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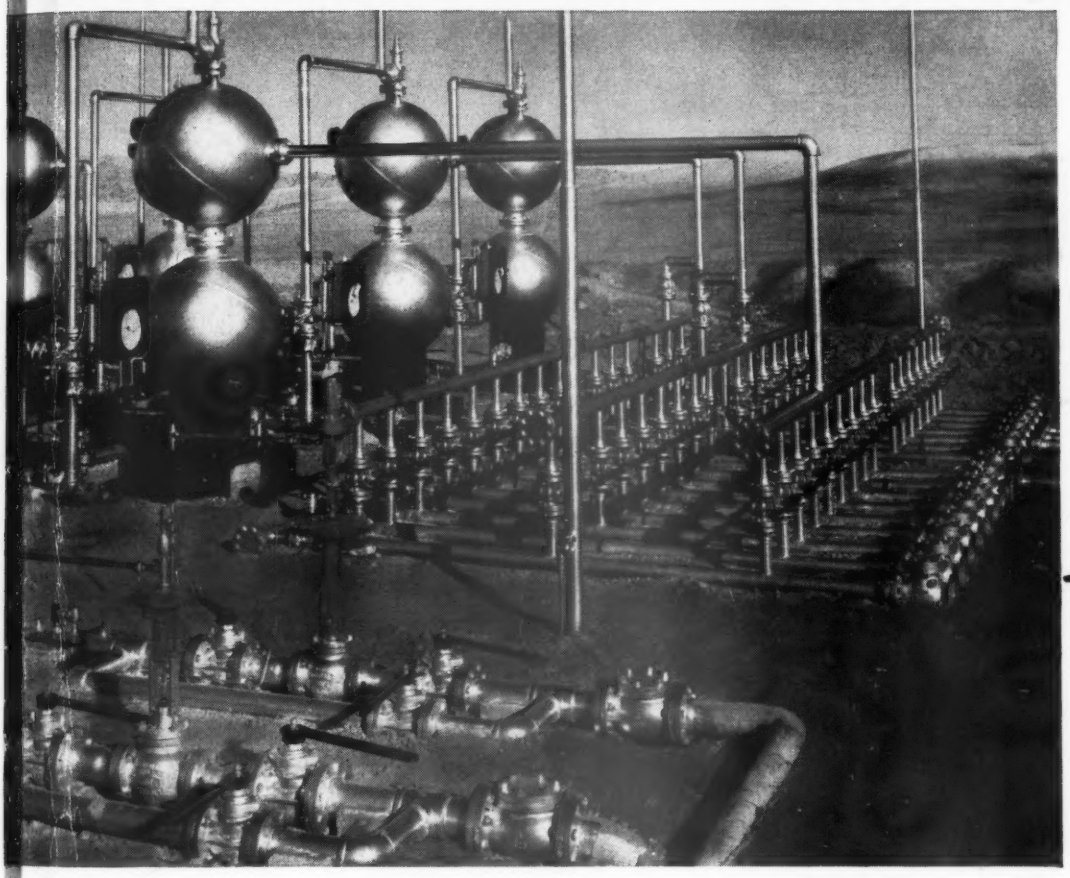
Petroleum Engineer

Combined Edition

Drilling and Producing | Refining and Gas Processing | Oil and Gas Pipelining



At Isolated Plants, where Repair Shops are Scarce,

Depend on NORDSTROMS

For remote installations, where the nearest maintenance crew may be miles away and shut-downs are especially expensive, the safe thing to do is to standardize on Nordstrom valves. For thirty years, many companies around the world have done so. The record of these thousands of trouble-free installations in isolated areas is the whole record of the growth and acceptance of Nordstrom valves.

Another Rockwell Product

Nordstrom Valves

LUBRICANT SEALED TO KEEP UPKEEP DOWN

Rockwell MANUFACTURING COMPANY 400 N. Lexington Ave., Pittsburgh 8, Pa.

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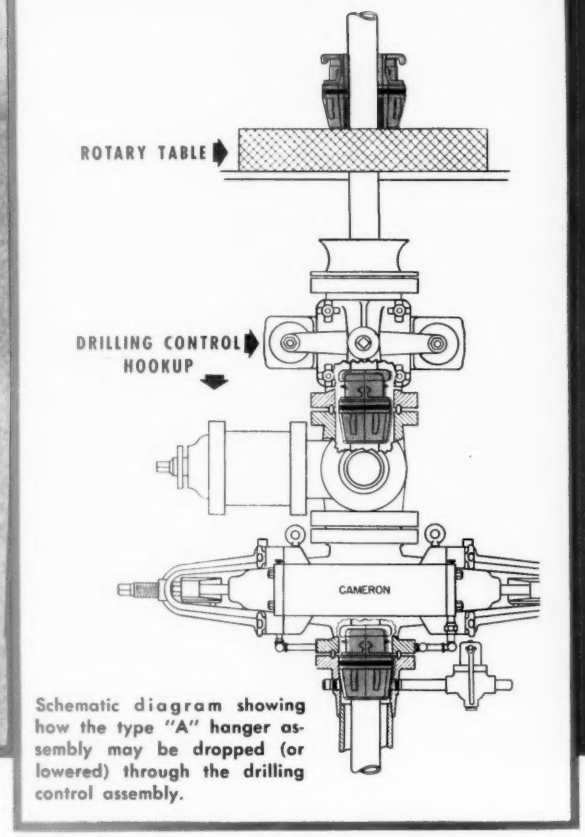
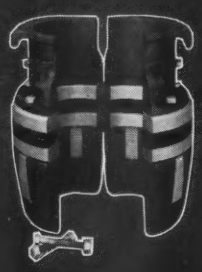
JANUARY 1952

A for AUTOMATIC — and to spell SAFETY in setting pipe!

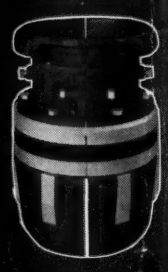


Schematic diagram showing how the type "A" hanger assembly may be dropped (or lowered) through the drilling control assembly.

Cutaway view of hanger in place, after removal of setting guide. Note wedges provided in slips which travel inward and upward upon contact with casing head to exert sealing compression on the packing ring.



Hanger assembly in unlatched position.



Hanger assembly in closed, or latched, position.

Simply wrap, latch, and drop. The Cameron Type "A" Casing Hanger seals automatically — it never forgets. There's no chance for human error. The instant the hanger seats in the casing head and the pipe is suspended, the seal is made *automatically*. The preventers may be lifted without danger of a blowout between casing strings.

Installation is simple. The hanger assembly is either dropped through the rotary and preventers to its seat in the casing head, or it may be fastened to the pipe by means of set screws and lowered into the casing head while running pipe. A setting guide prevents the hanger from becoming "cocked" on the pipe when it is dropped through the preventers.

Interested operators are invited to write for complete details on the full line of Cameron Forged Steel Well Heads, or see the Cameron section in the new Composite Catalog of Oilfield Equipment.

Cameron 1st *name in drilling control*

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THE Petroleum Engineer

COMBINED EDITION

• Drilling and Producing • Refining and Gas Processing • Oil and Gas Pipelining

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The PETROLEUM ENGINEER Publishing Company, Irwin-Keasler Building, DALLAS 1, TEXAS. W. L. LOVE, *President;* W. T. BRYAN, *General Manager and Treasurer.* **Editorial Staff**—K. C. SCLATER, *Vice President and Editor-in-Chief;* ERNESTINE ADAMS, *Managing Editor;* ARCH L. FOSTER, *Editor, Refining and Gas Processing;* FRANK H. LOVE, *Editor, Oil and Gas Pipelining;* RICHARD SNEDDON, *Editor, Pacific Coast,* 1106 B North Louise Street, Glendale 7, California. Phone, Chapman 5-1951; MARY MORRIS LYMAN, *Assistant Editor;* HENRIETTA O'BANNON, *Art Editor.* **Advertising Staff**—T. J. CROWLEY, *Vice President and Advertising Manager;* New York—JOE B. WOODS, 52 Vanderbilt Avenue, New York 17, New York. Phone MUrray Hill 4-1880; Chicago—E. V. PERKINS, 53 West Jackson Blvd., Chicago 4, Illinois, Phone, HArrison 7-6883; Los Angeles—RICHARD P. McKEY, Bendix Bldg., 1206 South Maple, Los Angeles 15, California. Phone PRospect 3919. **Promotion**—ABBOTT SPARKS, *Manager;* ROYAL COURTNEY, *Assistant Circulation Manager.*
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the Course of OIL

Synthetics—When and From What?

THE benefit to the public of the free flow of ideas is being proved again in the wide open discussion of synthetic fuel. The oil industry, the coal industry, the U. S. Bureau of Mines, and any of their personnel can get into the act and frequently do. It can be reasonably certain—barring socialistic political trends or sudden war—that the U. S. consumer will end up with the best and cheapest fuel that great technological minds can devise, whether it is from petroleum, shale, or coal.

The fact that there are now differences in estimates for costs of synthetic products, for amounts of steel needed, for the choice of basic material, is of minor importance in this beginning phase. If we are to hold onto a free enterprise economic doctrine, all these details will be threshed out in competition for markets by companies who risk their capital in new developments.

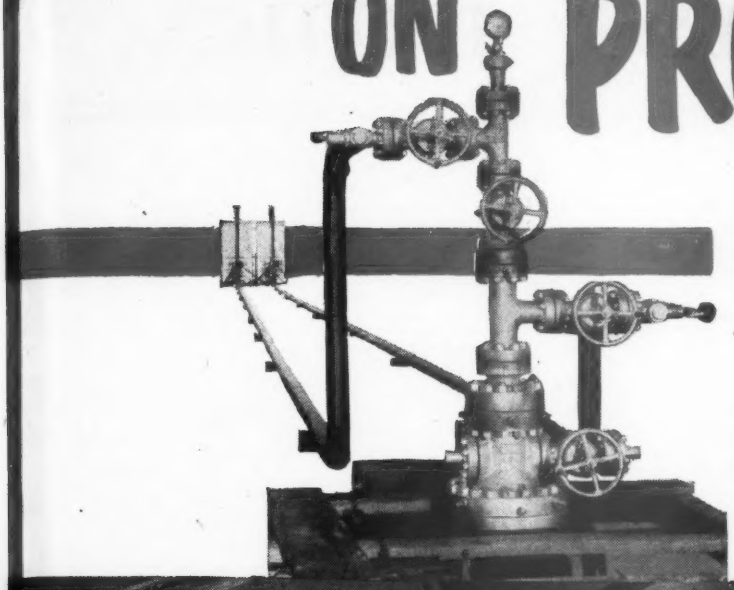
On page A-37 in this issue Clyde Berg, one of those who know most about it, describes how oil shale can be developed into a supply of oil products, nearly ready right now for competition with petroleum products. The U. S. Bureau of Mines has played a stellar role in investigations of the possibilities of oil shale. Large areas of the shale in western states have been set aside as Naval Petroleum Reserves. Other large areas have been leased by oil companies, which have also spent considerable sums in research to find the best methods for extracting and refining this base for fuel.

At the present time there is much in favor of oil shale development as compared with coal synthesis. The most important is that oil shale has no use as is—coal already supplies almost half the fuel demand of the U. S. A. Why not put the hitherto vast but unused resource of the West into the market—if there is such a market. The huge section of coal users has a tremendous plant of furnaces for that fuel, which would be obsolete under any widespread synthesis of coal.

The impetus for synthetics at this time comes mostly from federal government sources, which point to the steady rise in imports of petroleum. One of the chief reasons for this unbalance of domestic supply is federal control of vast areas of land and submerged lands, which are not being developed because federal control hinders development. We have examples in numbers of government pessimism about our oil resources—following which our oil supply over reaches demand. The fact that so many of these logicians overlook is that development increases our resources not arithmetically but geometrically—or at least somewhere in that proportion. East Texas didn't yield one billion barrels—it will yield 5½ billion (or more) but it took 20 years of development to find that out.

Our conclusions are two: First, an unhampered oil industry can produce an ample supply at present—specifically if the submerged offshore lands are put under state control as the majority of Congress voted to do; and, second, that development of oil shale should have precedence over development of coal hydrogenation because shale is now completely unproductive but can be developed to yield products competitive in price to petroleum, whereas coal synthesis probably would not be competitive without government subsidy and coal is already in great demand for almost half the mechanical energy transformers in the U. S.

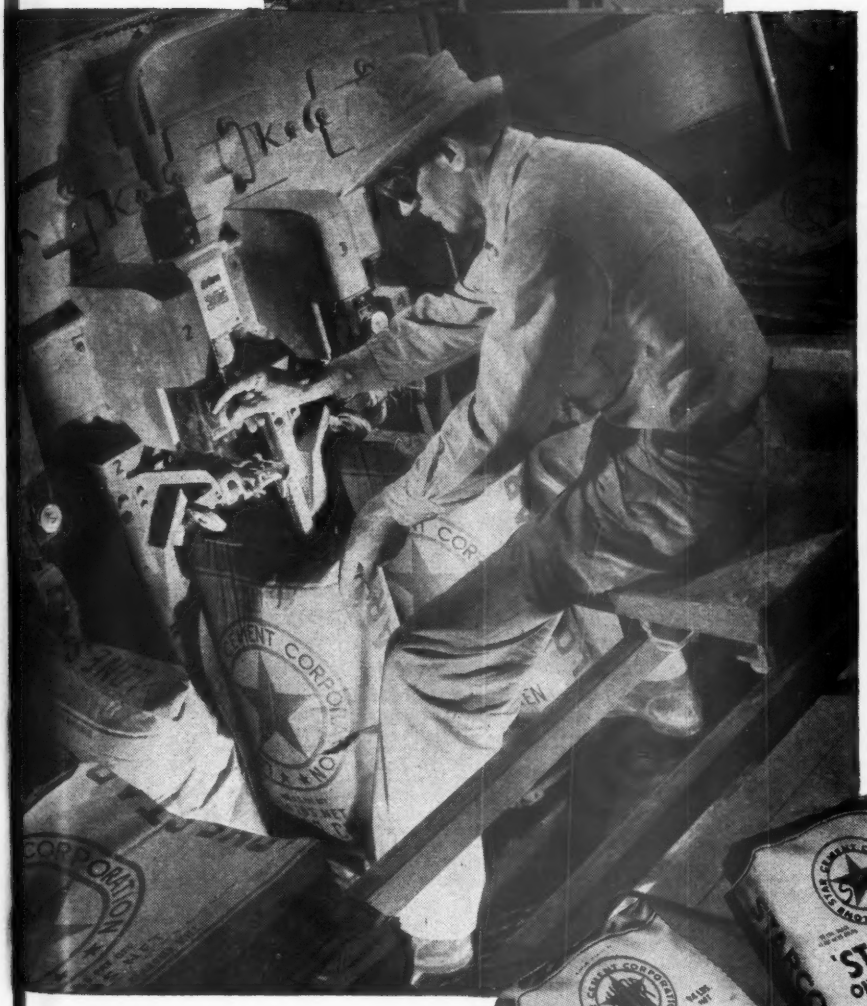
ON PRODUCTION

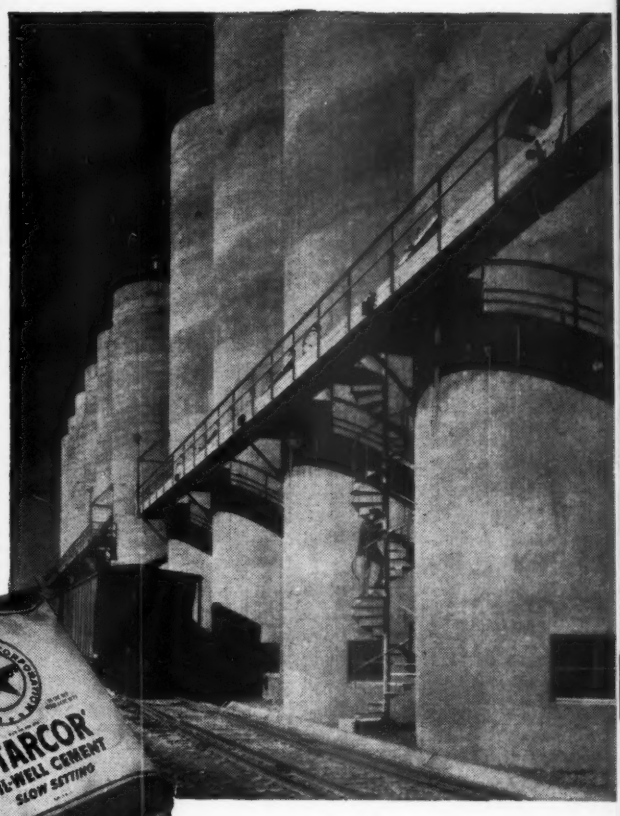


● "Christmas tree", flow lines and tanks... signal that the well is "on production" . . . oil starting on its long journey to the ultimate consumer.

"On production" at the cement plant is typified by the huge, concrete storage silos, each holding 40,000 sacks of cement...by the bulk cement flowing from the silo to the special covered railroad car...by the packing machines filling sacks for loading into box cars.

Each brand or type of cement has its own storage silos and packing machine...quality cements to meet the varied requirements of the oil fields.





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on equipment to pump a 5,000-ft. well

. . . by purchasing "OILWELL" PUMPING UNITS which are now designed with an offset saddle-trunnion assembly, illustrated above.

Together with "Oilwell's" TALLER samson posts and LONGER walking beams, this new feature provides an extended range of stroke lengths that often result in achieving the production you desire with:

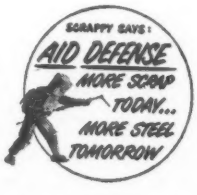
- **SMALLER SUBSURFACE PUMP . . .** permitting the use of insert-type pumps which also reduce "pulling" costs.
- **SMALLER SUCKER-ROD AND TUBING STRINGS . . .** or extra service life from the same grades and sizes.
- **SMALLER REDUCTION-GEAR NEEDED . . .** resulting in lower initial costs of equipment.
- **LESS HORSEPOWER INPUT . . .** permitting the use of smaller engines or smaller electric motors with corresponding savings in fuel or current.

*** Average saving in cost by using smaller rods, smaller tubing, smaller gear and smaller pump with "Oilwell" Pumping Units in LONG STROKE position.**

Study . . . the selected set of conditions illustrated in the table below . . . then ask your "Oilwell" Representative to work out a long-stroke comparison based upon your own well conditions . . . and SEE FOR YOURSELF how much you can save by standardizing on "Oilwell" Production Equipment.

DEPTH OF WELL—FT.	STROKE LENGTH IN.	BORE OF ROD PUMP IN.	SUCKER RODS LENGTH—FT. X SIZE—IN.	TUBING SIZE IN.	STROKES PER MINUTE	A.P.I. PEAK POLISHED ROD LOAD LB.	PEAK TORQUE IN.—LB.	AVERAGE H.P. OUTPUT AT GEAR	COUNTER WEIGHT REQUIRED LB. EFFECTIVE AT POLISHED ROD	"OILWELL" UNIT REQUIRED	BARRELS PER DAY THEORETIC
5000	54	1¾	1650′ of ⅞″ 3350′ of ¾″	2½	16	16,634	*130,291	19.65	11,808	34E17	146
5000	64½	1½	5000′ of ¾″	2	16	14,235	**118,203	17.83	10,550	24E17	172

Slippage and Overtravel Neglected. Specific Gravity 1.
Torque Figured on 0.8 Fluid Weight x ½ Stroke x Impulse Factor.
*Requires an "Oilwell" D-34 Speed Reducer with a Peak Torque of 166,700 in.-lb.
**Requires an "Oilwell" D-24 Speed Reducer with a Peak Torque of 120,600 in.-lb.



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TULSA, OKLA. . . . LOS ANGELES, CALIF.

USS TRADE MARK

"OILWELL"
TRADE MARK

UNITED STATES STEEL

With The EDITORS . . . . . .

A Great Accomplishment—

Dedication of the Texas Illinois Natural Gas Pipeline Company system during the month of December marks the completion of still another link in the vast and ever-growing pipe line system that is helping to develop the industry of the United States and contribute to the comforts of its people. This 1417-mile line, which cost an approximate $135,000,000, is the first connection of the Gulf Coast area of Texas with the Chicago metropolitan area. The fuel transported through this steel vein will find utility in the heating of homes and the firing of industry's furnaces.

It was a great accomplishment and one that required the cooperation of many people. For completion of the project in approximately 15 months despite many obstacles, President J. J. Hedrick gave praise to the skill and efforts of Texas Illinois engineers and executives, to the contractors, and to material suppliers. He also made a significant statement at the banquet, which was a part of the dedication ceremonies, that we should like to repeat. He said: "Testing of the line upon completion indicated that the pipe, engines, and material used, and the workmanship, were unexcelled in the industry. Only seven minor imperfections were found after testing the line at 900-psi pressure. In my judgment, no state or federal control over design and construction of pipe lines is necessary for the industry as has been suggested in some quarters."

With this example of efficiency before them, it is, indeed, something for those who advocate such a course to think about.—F. H. L.

More Petroleum Aromatics—

The current production of aromatics, benzene, toluene, and homologues from petroleum sources is having its effect on domestic production. Completion of projected capacity in the industry for "synthesizing" and recovering aromatics will increase the industry's contribution greatly, possibly more than doubling it. Benzene production for this year's total is expected to be 6,200,000 bbl (260,000,000 gal), of which more than 10 per cent will be from petroleum sources, probably. During the three summer months petroleum's share was more than 6,000,000 gal, with more producing capacity going 'on stream' from week to week.—A. L. F.

Knock and Anti-Knock—

The great Ethyl Corporation organization was built on one idea, the manufacture, sale, and application of a compound that when added to four-cycle (gasoline) engine fuels in microscopic quantities would suppress or retard the destructive and power-killing knock. Use of this compound, tetraethyllead, or TEL has expanded until it is one of the major items in the automotive industry. Now the same company comes along, is producing and selling amyl nitrate, chemically a distant cousin of "banana oil", for addition to diesel fuels to increase the "knock" in those fuels. More exactly, TEL slows down the burning rate of motor fuel, gasoline, a very advantageous thing. Amyl nitrate does essentially the opposite in diesel fuels that are higher boiling than kerosine; the prime quality in these fuels is rapidity of ignition when heated to the ignition temperature, and the nitrate speeds up that ignition, starts, and continues it at lower temperatures and pressures. This additive increases the amount of diesel fuel that can be made from any fraction, improves the ignition quality of poor fuels, and power efficiency of engines.—A. L. F.

Low Cost Energy—

Two of the largest and most essential industries in the nation join in the small but highly important organization, the Petroleum Electric Power Association: Our own industry and the electric power industry, which supplies the oil and gas industry with the great quantities of power needed in the production, refining, and transportation of petroleum. The PEPA is concerned with finding the most effective use of this power.

Besides this mutual business relationship the two industries have much in common. Each is contributing a vast supply of energy to the nation. Each has, through aggressive selling and strong management, been able to keep its products lower in cost than other commodities. Each has had to face increasing federal competition and federal controls. Each has spent billions of its earned capital to expand its plant in order to supply its increasing market smoothly, without the inconvenience of shortages. The U. S. electric power industry produces about half the world's power production; the U. S. petroleum industry produces half the oil production of the world. Certainly, both of these industries deserve the respect of a well-served public.—E. A.

Contractors' Meeting—

The Pipe Line Contractors Association is holding its fourth annual convention in Houston, Texas, January 8 and 9. As a comparatively newcomer to the industry association group, this organization has had a rapid and justifiable growth, and has been instrumental in solving for its members certain problems that could not be solved individually.

As proof of growth, there are now 43 active members, pipe line contracting firms that have constructed virtually all cross-country pipe line systems during the last several years. Then there are 64 associate members, firms engaged in subcontracting, manufacturing of equipment, and suppliers.

This year, again, an excellent program will be presented, and whether you are a contractor, an equipment manufacturer or supplier, or just interested in what the industry is thinking about, attendance at the meeting will be wortwhile.—F. H. L.

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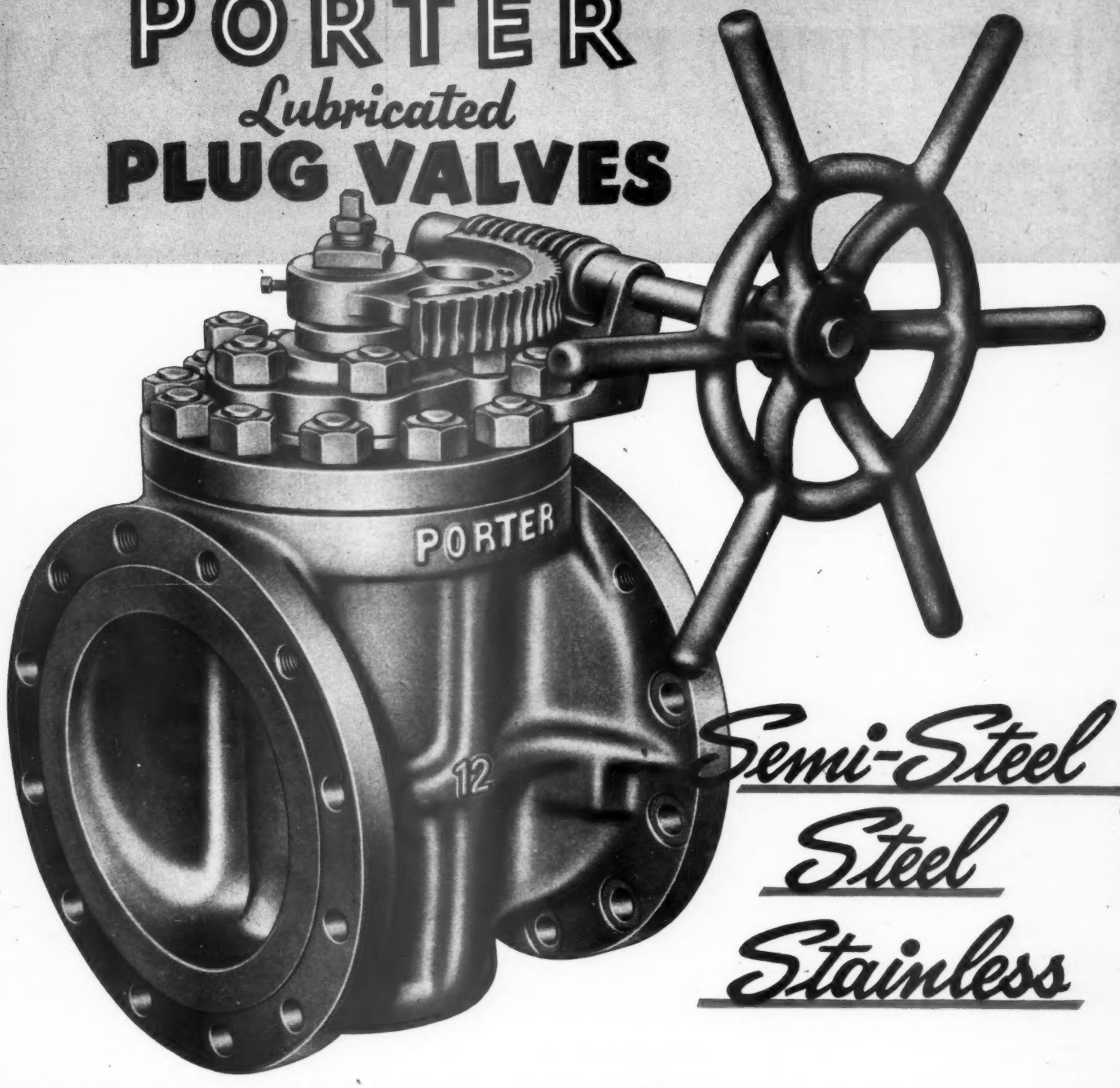

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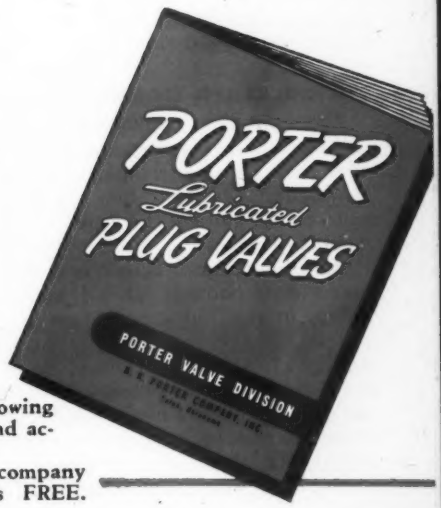

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HIGHLIGHTS IN OILDOM

OIL INDUSTRY MAY SEEK PRICE RISE

The petroleum industry may soon ask for a 50 cents per barrel increase in the oil ceiling price, as a result of the recent price order issued by the Office of Price Stabilization. OPS Regulation 21 covers price increases permitted under the Capehart amendment to the price control law extension, and is primarily aimed at manufacturers. Although the regulation did not mention the petroleum industry, a press release issued at the same time the regulation was, stated that the oil industry was included. The Capehart amendment provided that prices could be raised to account for increased costs in production since the Korean War began.

PACIFIC STATES OIL SHORTAGE SEEN

To avert a threatened oil shortage in the Pacific states, the Petroleum Administration for Defense has recommended that the military shift its buying of petroleum products to the Gulf Coast. The Pacific Coast, which has been supplying military products, has plenty of refining capacity, but not enough crude oil to meet all demands in the area, it was reported. California has 56 refineries, with combined crude capacity of 1,101,104 bbl daily—658,200 bbl cracking. Crude oil production averages 986,000 bbl daily.

OIL POWERED MOTORS INCREASE

A recent report made by the National Petroleum Council has shown a big increase in the number of items powered by petroleum products. Except for the war years and depression, there has been a steady increase in the number of motor vehicles and in equipment for heating and industrial purposes. The council reported that there were 23,016,000 passenger cars on the highways in 1930, and an estimated 42,846,000 this year. Commercial-industrial oil burners jumped from 176,240 in 1935 to 444,778 in 1950.

PAD CHECKS LPG STORAGE

Approximately 13,000 LPG producers, marketers, distributors, and dealers have received questionnaires from the Petroleum Administration for Defense concerning storage facilities of LPG. Aim of the questionnaires, according to PAD Administrator Brown is to find out about bulk storage at all marketing points in the industry, to assure that fullest use will be made of available storage in case of emergency. He added that sudden developments in defense needs could place a heavy burden on the industry, making it necessary that complete data about storage space in all areas of greatest consumption be on hand. Those receiving questionnaires are asked to report on the number of tanks they have and the total capacity.

JAPAN SHIPS STEEL TO U.S.

The first shipment of oil field pipe from Japan has arrived at the Texas Gulf Coast consigned to Atlas Pipe, Inc., of Houston. The steel mills of Japan, formerly engaged in manufacturing implements of war, have been manufacturing line pipe and casing for the oil industry. American engineers in Japan at the time are inspecting the finished products and aiding in setting up mill practice to conform with API specifications.

NLRB SAYS BONUS PART OF WAGES

A Christmas bonus paid employees over a 12-year period constitutes an integral part of the wage structure, was the finding of the National Labor Relations Board recently. The Board ordered the company in question to bargain with the union, saying the bonus was subject to collective bargaining. Automobile workers of Niles-Bemont-Pond Company had asked the company to negotiate with their union on the Christmas bonus, claiming it was a part of their wages. The company had refused, terming the bonus a Christmas present.

ELK HILLS PRODUCTION UNLIKELY

Oil men can't see much hope for the opening of production in Elk Hills (California) Naval Petroleum Reserve to raise West Coast refinery runs to meet military and civilian demands. This would first require that the President find it was necessary, then Congress would have to approve it. Before such a move is made, other measures—including civilian rationing—would have to be tried and found inadequate to supply military requirements.

MEXICO TO TRADE OIL FOR STEEL

From Mexico City comes a report that Mexico has agreed to trade "four or five shiploads" of oil to Western Germany in exchange for steel pipe. The source of information reported that the deal had been completed and that "oil is ready to go out when the tankers come for it". Value of the oil shipped to Germany was reported as "about half a million dollars".

URGES STATE RESPONSIBILITY

New chairman, Governor Sid McMath of Arkansas, told the Interstate Oil Compact Commission recently that states must keep their regulations "modern and up to date so as to take advantage of the newest technological developments in oil and gas production." He added that the states were aware of the vital need of uninterrupted production of oil and warned that unless they took care of conserving their oil, they "may find some agency of the federal government ready and willing to step in and assume this obligation."

DEPLETION TAX ESSENTIAL: SMITH

Without the 27½ per cent depletion allowance on their tax bills, it would be "virtually impossible" for operators to discover new oil and gas fields, Clarence T. Smith, Flora, Illinois, told the Interstate Oil Compact Commission recently. He added that continuation of the depletion allowable is essential to the conservation programs, as "oil and gas must be found before it can be conserved."

NATURAL GAS CONTRACT SIGNED

Humble Oil and Refining and Southern Production Companies have recently completed a deal whereby they will exchange natural gas between themselves. The contract grants a first call for each company on reserves in certain fields owned by the other, estimated in each instance in excess of 7 billion cubic feet of natural gas.

U.S. PETROLEUM SETS NEW RECORDS

The American petroleum industry set new records in every phase of the industry in 1951, the Investment Bankers Association of America was told at its 40th annual convention. New highs were set in production, refining, exploration, development, and marketing. A record total of more than 44,000 wells were drilled in 1951, as compared with 43,000 in 1940. Wildcat operations are running 25 per cent ahead of last year.

NAM SETS UP OIL DIVISION

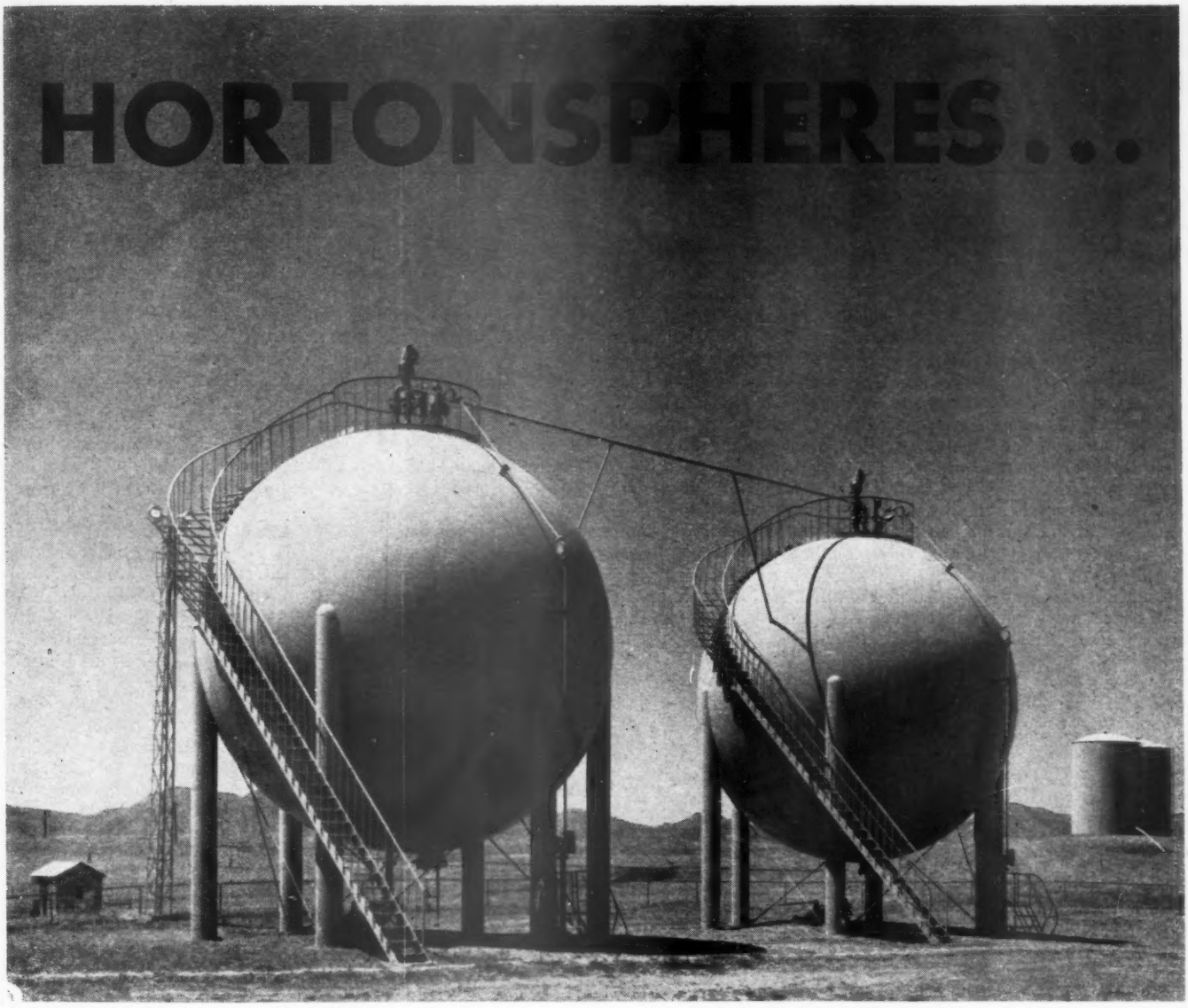
The formation of the Petroleum Division of the National Association of Manufacturers' Southwestern Regional Advisory Committee has been announced by Robert L. Humphrey, regional manager. Temporary chairman is John W. Newton, vice president, Magnolia Petroleum Company.

McMATH HEADS IOCC

Governor Sid McMath, of Arkansas has been elected the new chairman of the Interstate Oil Compact Commission. He succeeds Governor Allan Shivers, Texas. Other officials elected at the commission's meeting in Little Rock, Arkansas include: Jeff Robinson, first vice chairman of the commission, also chairman of the Kansas Corporation Commission; C. E. Eddy, state director of conservation in Michigan, second vice chairman, and Earl Foster of Oklahoma City reappointed executive secretary.

TWO IRAN COUNCILMEN RESIGN

In the tempestuous oil circles of Iran two members of the government oil commission have resigned in reported protest against plans to sell nationalized oil to Russia and its satellites. Senators Abolghassem Majm and Mohammed Ali Sourouri, however, reported they quit because seven months after enactment of the law to nationalize the British-Anglo-Iranian Oil Company concession, nothing had been done about it.



Don't Let Profits Disappear into Thin Air

During 1948, The California Company completed a recovery plant for processing natural gas from the Rangely, Colorado, field. The two 2,000-bbl. Hortonspheres shown above are used to store natural gasoline produced at the plant.

Pressure storage of natural gasoline in Hortonspheres prevents the excessive losses that occur from storage in atmospheric pressure tanks. Hortonspheres don't vent the light fractions that give natural gasoline most of its value as an ingredient of blended motor fuel. They also prevent the accumulation of explosive or toxic vapors in the storage area and thus reduce fire hazard.

Hortonspheres are economical to build because every pound of metal used in their construction directly resists internal pressure. They cost less to paint and maintain because they have less surface area per barrel of capacity than containers of any other shape.

For more complete information about Hortonspheres, Hortonspheroids, Hemispheroids, Horton Floating Roofs, Hortondome Roofs or any other Horton vapor-saving structure, write our nearest office. Our experienced staff of engineers, fabricators and erection crews are always ready to provide you with finer storage facilities.

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Boston 10.....1028—201 Devonshire St.
Chicago 4.....2481 McCormick Bldg.
Cleveland 15.....2251 Guildhall Bldg.
Detroit 26.....1538 Lafayette Bldg.
Houston 2.....2137 C & I Life Bldg.
Los Angeles 17..1546 General Petroleum Bldg.
New York 6.....3373—165 Broadway Bldg.
Philadelphia 3..1635—1700 Walnut Street Bldg.
Salt Lake City 4.....529 West 17th South St.
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PETROLIC PERSONALITIES

DICK SNEDDON

PIONEERS HOLD CONVERSAZIONE

A gathering of unusual consequence anent that we shall discourse briefly here was the annual fall meeting and conversazione of the Petroleum Production Pioneers, held at the Rodger Young Auditorium in Los Angeles, December 8 last. This fandango brought together approximately 650 pioneers, junior and senior, who had more fun and frolic than a bunch of high school girls at their first prom. Opening in the usual manner with an extended cocktail hour during which Hudson Drake, the Belridge Oil Company purchasing agent and his toters of the titillating waters did a yeoman job of chasing away any lurking blues and inhibitions.

Included in the Drake Dragoons were such well known potion concoctors as Leland Laird, the Baash-Ross Caledonian, on whose divots many a settler has builded his humble home; Ed Embury, the good looking young Guibersonian whose jigger handling at these affairs has attracted national attention; Glen Pitts, the irrespressible Republic Supply Company chap and leading industry entertainer; and Bill Bates, the unassuming but nonetheless competent Shell Oil Company drilling superintendent.

BANISHERS OF LOATHED MELANCHOLY

Others who aided in the dispensing of liquid glee and the banishing of "loathed melancholy" were Dutch Lortscher, the handsome young purchasing agent from Signal Oil and Gas Company; Don Pinnell, an interesting member of the 76 and Triton group and no slouch at blending the ingredients; Rudy Switzer, the tall, collegiate looking lad who holds forth at the Southwest Exploration headquarters and is also a stout pusher for the Bob Pyles Boys Camps; Wayne Glen, delegate from the Continental Oil Company, a dark complexioned lad with a most illuminating smile.

Joe Bergeron, the Baash-Ross Parisian, at whom we frequently hurl our two French phrases in the hope of impressing some nearby gazabo with our profound knowledge of the language, which is actually zero; Ed Pellegrin, the cleancut Macco executive whose prowess as a big game fisherman is known all the way from Mazatlan to Guaymas and back; and rounding up the gang, Bud Fobes, the Baker Oil Tool Company redhead who, we understand, is going to Canada any day now and will be there for quite a long time.

OF LIBERTY LIN ET AL

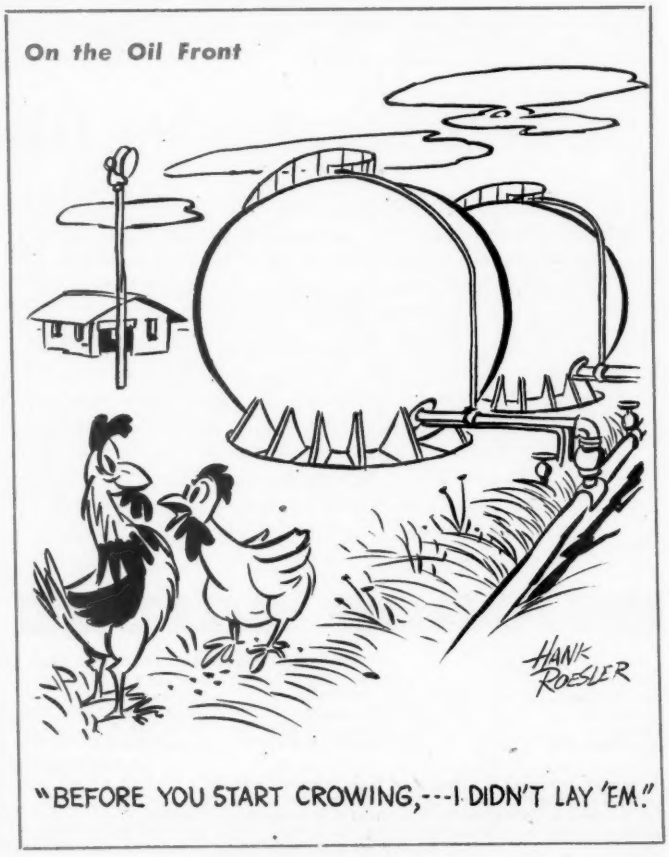
Gracing the head table were some of the real old timers of western petroleum, including Dick Guiberson, native of Santa Paula and widely known manufacturer and designer of petroleum equipment; Jake Mohler, retired superintendent of drilling and production for The Texas Company; Ed Stearns, vice president of Universal Consolidated Oil Company, and a sharpie with a rifle, fishing rod, or billiard cue; Bill McLaine, retired vice president of General Petroleum Corporation, one of Stanford's earliest graduates and one of California's best known pioneers; Lin Little, retired Standard Oil production chief, once known as "Liberty Lin" because of his astonishing wartime sales of liberty bonds.

Fred Ripley, pioneer developer of the Fellows area of the Midway Field and noted C.C.M.O. executive; Frank Hill, retired Union Oil Company director of production and a veritable reservoir of interesting historical information; George Brown, prexy of Illinois Crude Oil Company, celebrating his birthday and being ably assisted in all the razz and ritual by his three good-looking sons; William Brown, old time Standard driller now living retired out in Whittier but still active and alert and enjoying life to the full, excepting when some short-sighted guy runs off with his hat; and Dad Kline, pioneer Oil Well Supply Company man, known to practically everybody in the California oil business.

AMONG THOSE PRESENT

Also qualifying in the pioneer category were A. E. Fowks, retired Union Oil Company executive whose English moniker, "Henry" was changed to "Enrique" by his Peruvian friends, and who is now honorary vice president of the PPP; Charlie Brewster, another famed Standard Oiler who is now observing the quaint carryings-on of his successors in the oil industry from a comfortable lookout in his hillside home in the north of Glendale; Bill Sutherlen, another substantial Standard Oiler who never misses the PPP doings and appears to enjoy them thoroughly; Clayton Severns, one of the daddies of the drilling contract business, but too modest to admit that he had anything at all to do with it—nice people just the same; Bill Clark, the diminutive and very reticent Union Oiler who also thinks he had nothing to do with the history of the oil business although he was one of the drilling crew on the Lakeview gusher; W. O. "Bill" Todd, former Standard Oiler, drilling contractor, and now a much feared exponent of gin rummy around the Wilshire Country Club; Elmer Bolton, one of our favorite people, former Ohio Oil Company executive, and Al Rosenleib, another consequential member of the same institution, George Kammerer, manufacturer of oil equipment;

Jim Clayton, the Baroid ambassador, a right gentlemanly chap and we don't know how much money he has but we do know that he has a wealth of friends; Al Tietze, big, genuine, Standard Oil pioneer in production, a chap you can like without even trying. Al has been under the weather for a while but we were pleased no end to see him looking as fit as Baron Leone; Chet Rasmussen, once a formidable employee of the Bunting Iron Works, now an equipment manufacturer; Neil Norris, with the Navada Petroleum Company in the early days, later associated with Cy Bell, and Tom Hickey, the genial prexy of Hickey Pipe and Supply Company.



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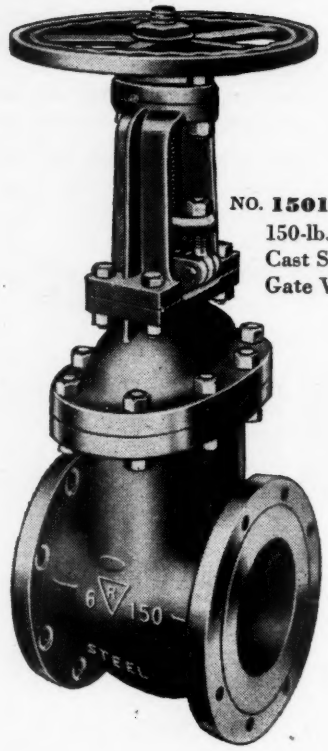

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MEETINGS

Jan. 8-9—**Pipe Line Contractors Association,** annual meeting, Shamrock Hotel, Houston, Texas.

Jan. 14.18—**Society of Automotive Engineers,** annual meeting, Hotel Book-Cadillac, Detroit, Michigan.

Jan. 17—**Southern California Meter Association,** Rio Hondo Country Club, Downey, California.

Jan. 17-19—**Institute on the Law of Oil and Gas Taxation,** third annual, Southwestern Legal Foundation, Dallas, Texas.

Jan. 21-22—**Compressed Gas Association,** annual meeting, Waldorf-Astoria, New York City, N. Y.

Feb. 3-8—**American Society for Testing Materials,** Com. D-2 on petroleum products and lubricants. The Shoreham, Washington, D. C.

Feb. 4-6—**Missouri Petroleum Association,** annual convention and trade exhibit, Jefferson Hotel, St. Louis, Missouri.

Feb. 7-8—**Instrument Society of America,** power plant symposium, Hotel Statler, New York City, N. Y.

Feb. 11-14—**Convegno Nazionale del Metano e del Petrolio,** Taormina, Italy.

Feb. 13—**Institute of Petroleum,** Manson House, 26, Portland Place, W. I., London.

Feb. 18.19—**American Petroleum Institute,** division of marketing, lubrication committee meeting, Hotel Book-Cadillac, Detroit, Michigan.

Feb. 21—**Southern California Meter Association,** Rio Hondo Country Club, Downey, California.

Feb. 25—**Institute of Petroleum,** Manson House, 26, Portland Place, W. I., London.

Feb. 26-27—**Wisconsin Petroleum Association,** Milwaukee Auditorium, Milwaukee, Wisconsin.

Feb. 28-29—**American Association of Petroleum Geologists,** Rocky Mountain section, Salt Lake City, Utah.

March 3-7—**American Society for Testing Materials,** spring meeting and committee week, Hotel Statler, Cleveland, Ohio.

March 5-7—**American Petroleum Institute,** division of production, Southwest district, Washington-Youree, Shreveport, Louisiana.

March 10-14—**National Association of Corrosion Engineers,** annual conference, Galveston Pleasure Pier and Buccaneer Hotel, Galveston, Texas.

March 11-14—**Plastics Exposition,** fifth national, Exposition Hall, Philadelphia, Pennsylvania.

March 12—**Institute of Petroleum,** Manson House, 26, Portland Place, W. I., London.

March 16-19—**American Institute of Chemical Engineers,** regional meeting, Biltmore Hotel, Atlanta, Georgia.

March 19-21—**American Petroleum Institute,** division of production, Mid-Continent district, Hotel Broadview, Wichita, Kansas.

March 22-April 6—**International Trade Fair,** Navy pier, Chicago, Illinois.

March 23-27—**American Association of Petroleum Geologists,** annual meeting, Los Angeles, California.

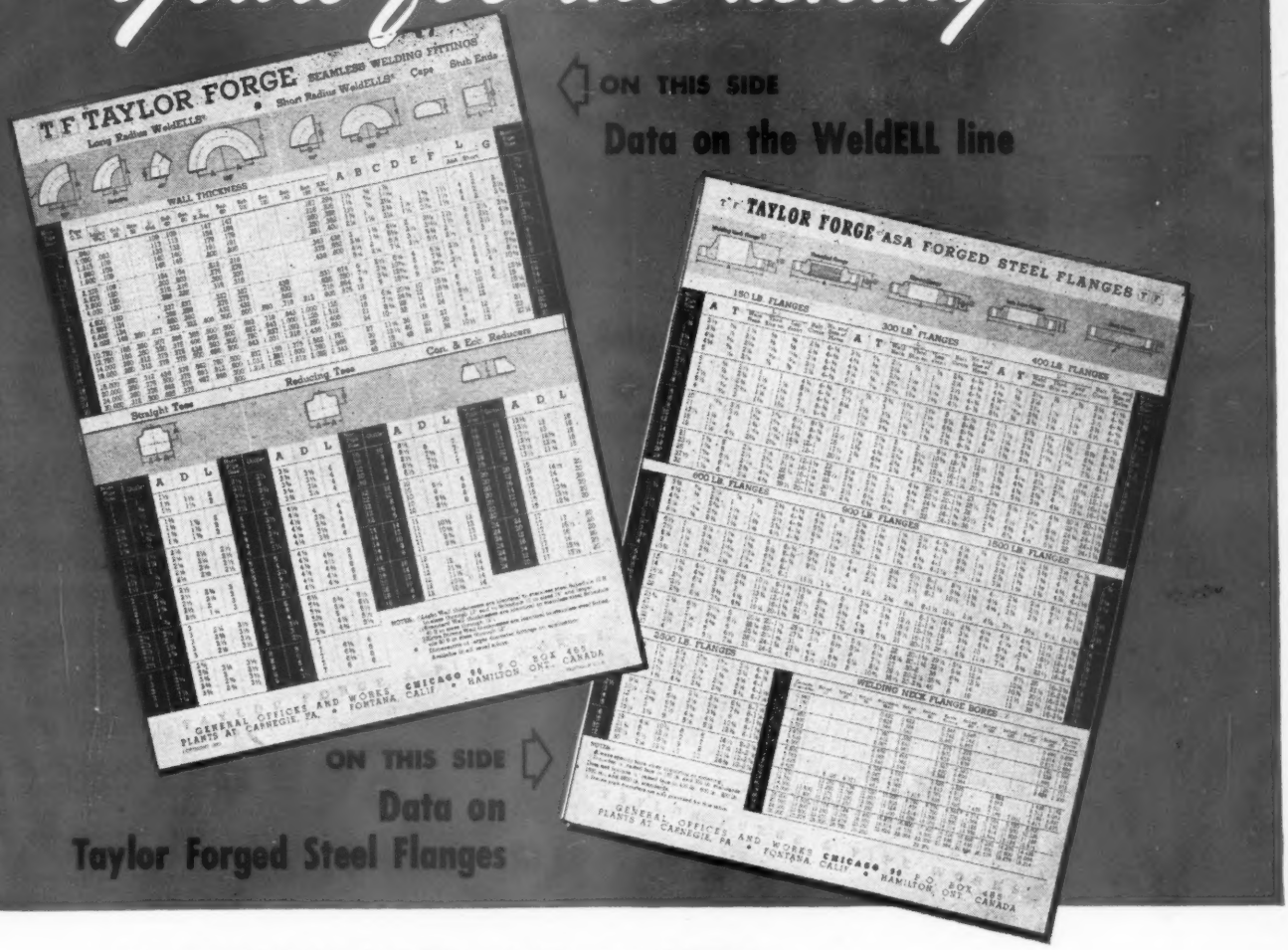
March 26—**Institute of Petroleum,** Manson House, 26, Portland Place, W. I., London.

March 31-April 2—**Western Petroleum Refiners Association,** annual meeting, Plaza Hotel, San Antonio, Texas.

April 2-4—**American Petroleum Institute,** division of production, Eastern district, Hotel William Penn, Pittsburgh, Pennsylvania.

April 8-10—**Southwestern Gas Measurement Short Course,** University of Oklahoma, north campus, Norman, Oklahoma.

Yours for the asking—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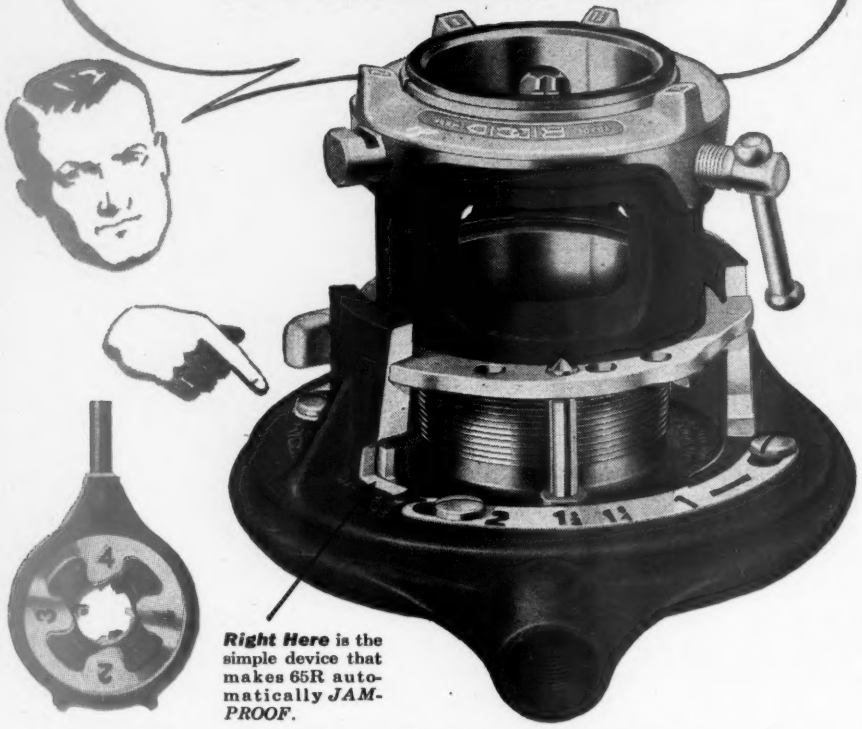

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April 16-18—**National Petroleum Association,** semi-annual meeting, Hotel Cleveland, Cleveland, Ohio.

April 21-23—**American Petroleum Institute,** division of transportation, pipe line meeting, The Blackstone Hotel, Fort Worth, Texas.

April 24-25—**American Petroleum Institute,** division of production, Rocky Mountain district, Gladstone Hotel, Casper, Wyoming.

April 28-30—**Southern Gas Association,** annual convention, Galveston, Texas.

April 30-May 1, 2—**Natural Gasoline Association of America,** annual convention, Rice Hotel, Houston, Texas.

May 5-7—**American Geophysical Union, National Academy of Sciences** and **National Research Council,** Washington, D. C.

May 11-14—**American Institute of Chemical Engineers,** regional meeting, French Lick Springs Hotel, French Lick, Indiana.

May 12-13—**American Gas Association,** natural gas department spring meeting, Biltmore Hotel, Los Angeles, California.

May 12-15—**American Petroleum Institute,** refining division mid-year meeting, St. Francis Hotel, San Francisco, California.

May 15-16—**American Petroleum Institute,** division of production, Pacific Coast, Biltmore Hotel, Los Angeles, California.

May 26-28—**American Gas Association,** production and chemical conference, Hotel New Yorker, New York City, N. Y.

May 29-31—**Seventh Annual Short Course in Gas Technology,** Texas A. and I. College, Kingsville, Texas.

June 8-12—**Canadian Gas Association,** Chateau Frontenac, Quebec City, Quebec, Canada.

June 9-14—**American Petroleum Institute,** midyear standardization conference, Brown Plaza Hotel, Denver, Colorado.

June 23-27—**American Society for Testing Materials,** annual meeting, Hotels Statler and New York, New York City, New York.

July 1-Sept. 30—**Centennial of Engineering,** Museum of Science and Industry, Chicago, Illinois.

Oct. 13-15—**Texas Mid-Continent Oil and Gas Association,** thirty-third annual meeting, Fort Worth, Texas.

Nov. 10-13—**American Petroleum Institute,** annual meeting, Chicago, Illinois.

Dec. 1-6—**National Exposition of Power and Mechanical Engineering,** Grand Central Palace, New York City, N. Y.

Dec. 7-10—**American Institute of Chemical Engineers,** annual meeting, Hotels Cleveland and Carter, Cleveland, Ohio.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York. Secretary Fred J. Jobst. c/o Val A. Wittich, Jr., 30 Rockefeller Plaza, New York 20, New York.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary E. F. Baldwin, Hughes Tool Company, Box 2539, Houston, Texas. WO-3101.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Secretary W. A. Wilson.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary R. E. Kirberger, Unit Rig Manufacturing Company, Tulsa, Oklahoma.

Dallas-Fort Worth Chapter, Dallas, Texas, First Monday of the Month. Secretary Gene Shiels, 205 Irwin-Keasler Building, Dallas, Texas. R1-4042.

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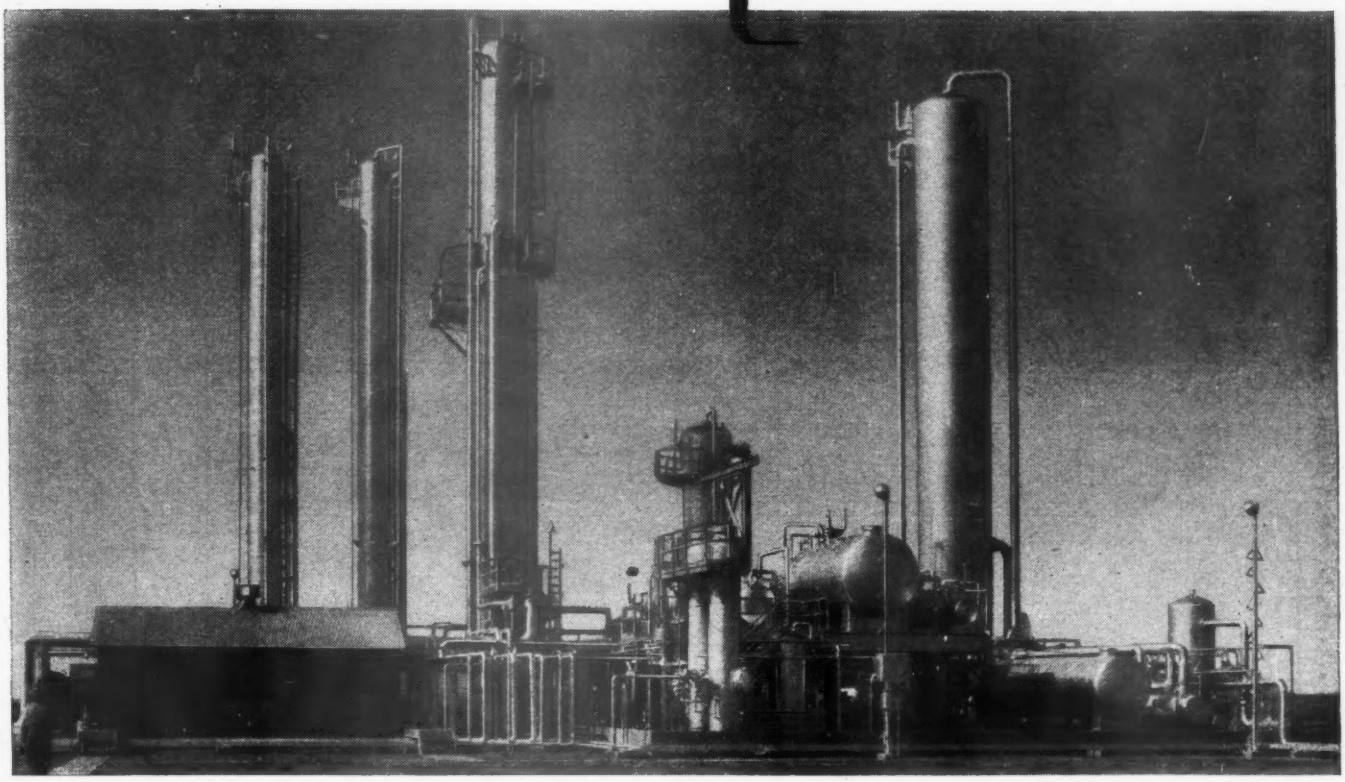

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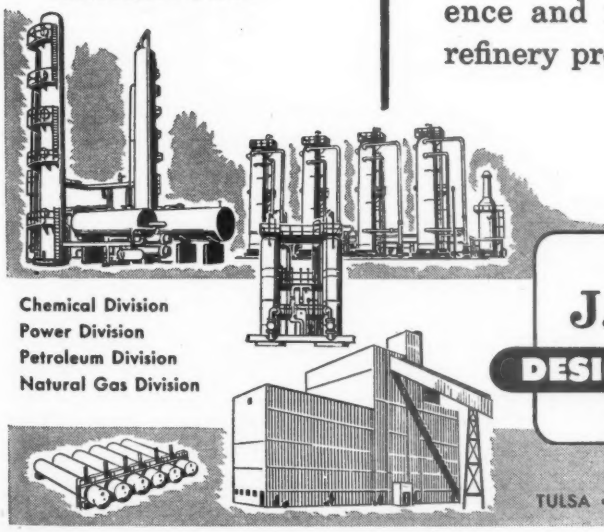

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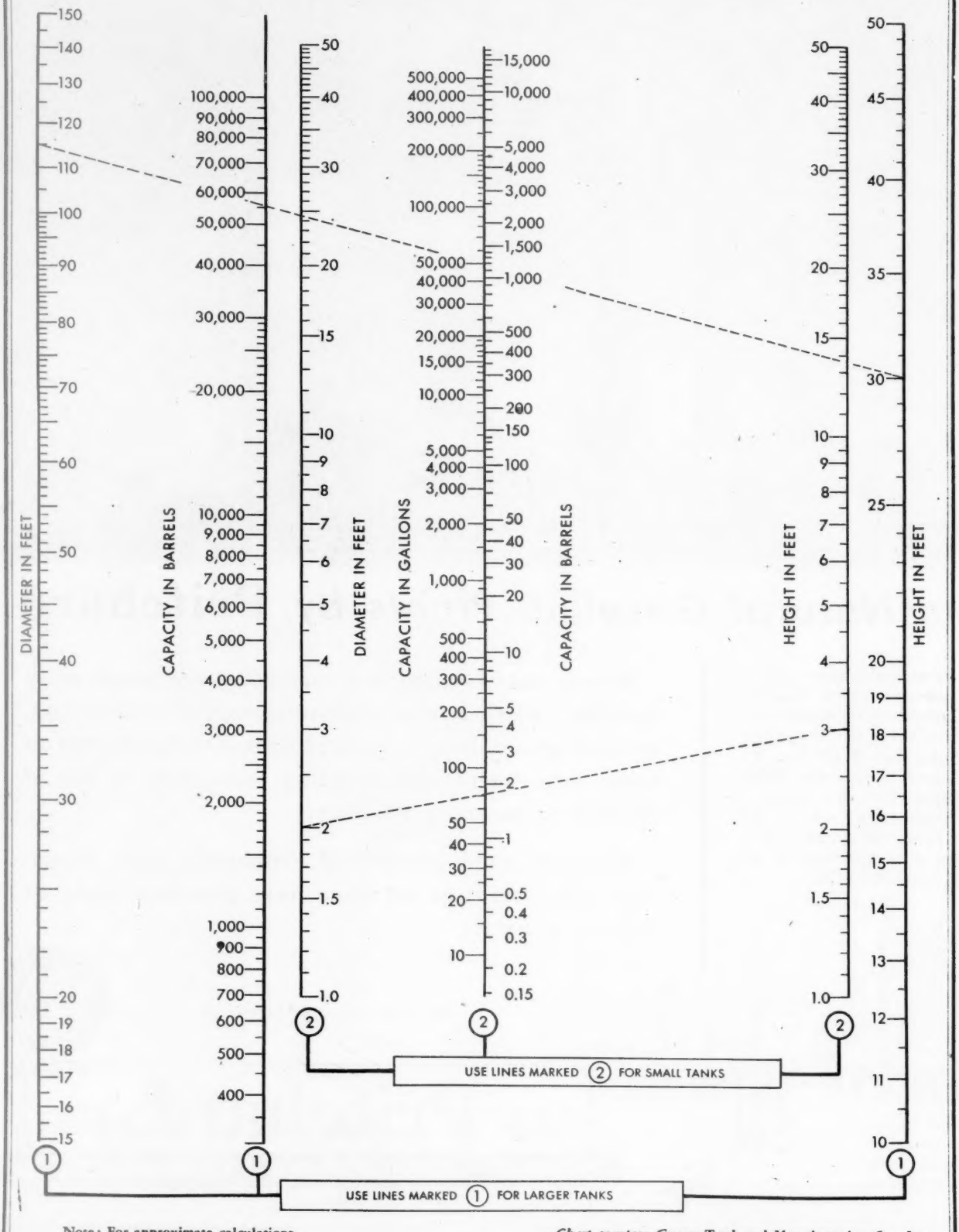

Note: For approximate calculations.

—*Chart courtesy Graver Tank and Manufacturing Co., Inc.*

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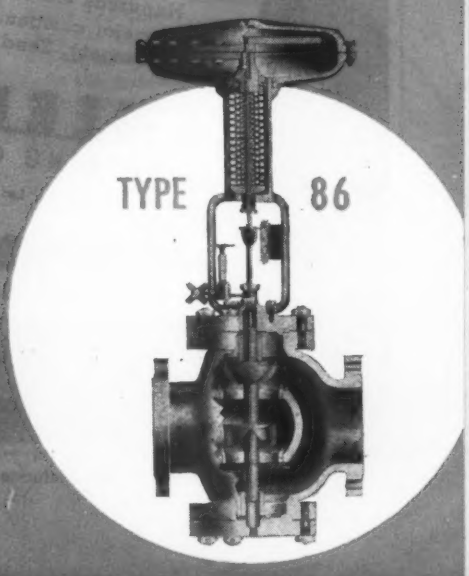

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LETTERS *to the* EDITORS

Seeks Clarification

To The Petroleum Engineer:

I have read with great interest in your October, 1951, issue of *The Petroleum Engineer* the article by Norman C. Wells entitled "Gas Anchor Design".

The problem of "de-gassifying" subsurface oil and water is one that has always intrigued me, but it is a problem that I have never seen a universal solution for.

The area in which I am now employed as a petroleum engineer is one noted for foamy, high gravity oil; and the pumping wells are noted for the low volumetric efficiency of the subsurface pumps.

If the author has the time or inclination I would greatly appreciate a clarification of one point that escaped me in his very well written article, i.e.: "What factor in his design insures that a gas-liquid interface will be created within the anchor?"

Joe M. Coffield

Oklahoma City, Oklahoma

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Reply by Norman C. Wells

In regard to your question on the article on "Gas Anchor Design" in the October issue of *The Petroleum Engineer*, I shall try to answer it in as simple a manner as I can in writing. You were concerned about what factor in the design insures a liquid-gas interface in the anchor chamber. Actually, this is insured by the pressure required to lift the ball in the ball and seat design of the gas ports at the top of the chamber. Then this design, coupled with the vertical distance from these valves to the pump inlet slots in the stinger insure keeping this liquid level below the gas vent valves, but above the top pump inlet shot in the stinger, in fluids (in the annulus) of densities ranging from 0.06 to 0.46 psi per foot.

I hope that this answers your question. Thank you for your interest. I have been very gratified by the interest aroused in the article.

Norman C. Wells

Professional Engineer
Long Beach, California

Contribution Praised

To The Petroleum Engineer:

Your article appearing in the November, 1951, issue of *The Petroleum Engineer* on "Geology and Oil and Gas Development and Possibilities of the Williston Basin" by Donald F. Towse is a valuable contribution on this new oil province. I shall appreciate receiving 25 prints of this article if available.

J. H. Barnett

Division Engineer
Stanolind Oil and Gas Company
Casper, Wyoming

☆ ☆ ☆

The average motorist pays 66 cents in taxes every time he buys ten gallons of gasoline.

☆ ☆ ☆

In 1950, oil marketers collected more than $2,000,000,000 in gasoline taxes for Uncle Sam and the states.

☆ ☆ ☆

America's 44,000,000 motorists paid an average of $82.36 in taxes to own and operate their vehicles last year.

☆ ☆ ☆

Heavy increases in motor vehicle registrations will give the states an automatic $215,000,000 extra in gasoline taxes in 1951.

☆ ☆ ☆

Missouri, Georgia, New Mexico, Nebraska and North Dakota reduced gasoline taxes in the past year saving motorists more than $33,000,000 yearly.

☆ ☆ ☆

Taxes on the typical motor vehicle and the gasoline it used last year added up to almost as much as the average motorists paid in federal income taxes.

☆ ☆ ☆

The federal gasoline tax of 1½ cents per gallon now costs taxpayers more each year than the total tax receipts of the national government from all sources 35 years ago.

FIG. 1.

Advances in developing oil shale make it possible to refine good quality products at prices competitive with petroleum

CLYDE BERG

THE shale deposit of the Green River formation of Colorado, Utah, and Wyoming is one of the major fuel sources of the world. The Picance Creek Basin of Northwestern Colorado alone extends over an area of 1000 sq miles. Utilization of the mahogany ledge of this formation, which averages more than 25 gal per ton, can yield one hundred billion barrels of oil, comparable to the world's known reserves of petroleum.

Interest in this important fuel source has been stimulated recently because of the threat of an all-out military effort with loss of the Middle Eastern crude supplies as well as future shortages of petroleum. A petroleum industry survey of the production of refined products from shale oil was made in 1951 under the auspices of the National Petroleum Council. This study is the most extensive and thorough evaluation of shale oil production costs made by the industry to date. Gasoline costs were found to be significantly higher than the current price of gasoline from petroleum. These costs were at such a level, however, that shale is the most economical synthetic fuel of the future and warrants continued attention by the petroleum industry. Important technical advances have been made in development of this fuel over the last three years.[1, 2]

It is the intention of this paper to review some of the more recent advancements in the technology of mining, retorting, and refining of shale and shale oil as well as to review the progress in the economic evaluation of the possibilities of utilization of this fuel.

Oil Shale

Oil shale of the Green River formation in Colorado was formed in an ancient lake in which a gradual deposition of both organic and inorganic material occurred. The water in the lake during the period of deposition was in a reducing condition so that the organic material was not oxidized. Principally, the organic material consists of fossilized spore cases and algae, together with some leaves, stems, and animal material. The inorganic material in the Colorado deposition consists of magnesium marlstone. In Fig. 1 is presented a photograph of the Parachute Creek area of the Colorado shale deposit. It will be noted that the shale formation is at an elevation of 5000 to 8000 ft and that the plateau in which the shale deposition is situated is penetrated by deep ravines of considerable depth and length. These ravines expose the face of the shale deposit to form convenient locations for opening mining operations. Exploitation of his huge Colorado shale reserve depends upon the combined ecomonic solution of mining, retorting, and refining of shale and shale oil.

Mining

The problem of mining of shale constituted a major limitation in the economic possibilities for utilization of shale for many years. The Bureau of Mines has effected an important advance in the successful mining of shale in the demonstration shale mine near Rifle, Colorado.[3, 4, 5] By utilizing modern large-scale ore-handling equip-

EXCLUSIVE

The Author

Clyde Berg is chairman of the Shale Oil Processing Subcommittee of the National Petroleum Council Committee on synthetic liquid fuels production costs. He has been with the Union Oil Company for 12 years and is manager of process development.

He was awarded the Hormel Research Fellowship and also instructed in the chemical engineering department at the University of Minnesota during his postgraduate work. In 1940 he obtained his Ph.D. and joined the Union Oil Company. He was appointed supervisor in charge of process development in 1942, assistant to vice president of research and development in 1949, and manager of process development in 1951.

Under his direction a wide range of processes has been developed. He has published articles on hypersorption, Cobalt Molybdate refining, hyperforming, and retorting and refining of shale oil, solvent extraction, distillation, etc.

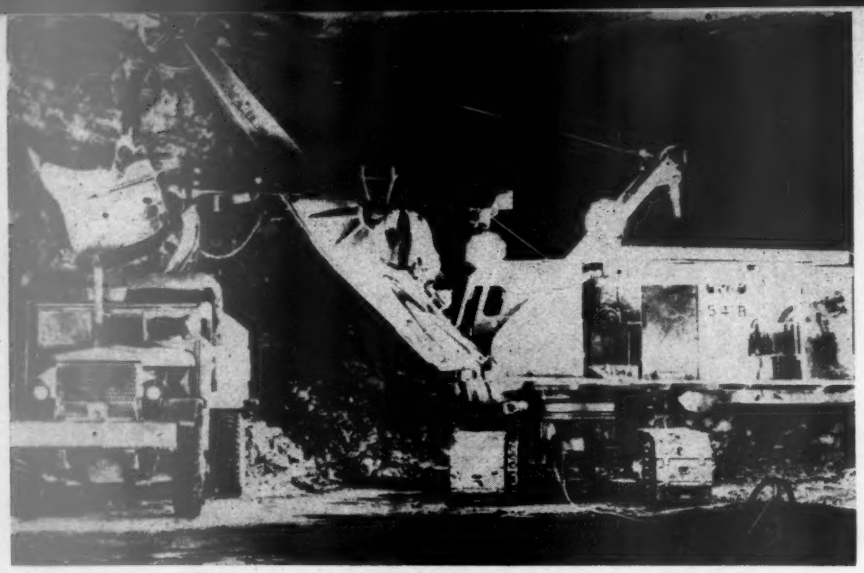


FIG. 2. Interior of U. S. Bureau of Mines demonstration mine.

ment, the cost of mining has been reduced to the range of costs obtained in the most modern open quarry operations. Since the strength of the Green River shale formation is two or three times that of concrete, large mining openings can be made without fear of roof failure, and rooms have been opened 70 by 100 ft in extent without the use of support beams. The most recent concept of the mining operation involves the room and pillar type of mining with approximately 75 per cent of the shale being removed, leaving only 25 per cent of the shale behind as support pillars. In Fig. 2 is given a photograph of the interior of the Bureau of Mines demonstration shale mine. In operation of the mine, drilling and blasting are employed to open the roof area, followed by drilling and blasting of the bench to break the shale, which is loaded by electric shovels into large diesel-driven trucks and hauled from the mine.

Retorting

Commercial shale retorts would be situated at the mouth of the mine to permit minimum handling of the raw shale and ash refuse. Crushing facilities would consist of a one-stage breaking operation to reduce the run of the mine to an aggregate maximum four-inch particle diameter. The flexibility of the retorting operation will permit adjustment of plant operations to meet fluctuations in shale supply, and only a minor installation of shale storage capacity is required.

Capacity of the ravines in the shale properties is sufficient to permit ready disposal of the ash discharge for an extended period of time and the transportation operation will be that of the retorted oil and the retort gas to the refinery site situated within a few miles of the mouth of the mine.

Union Retorting Process

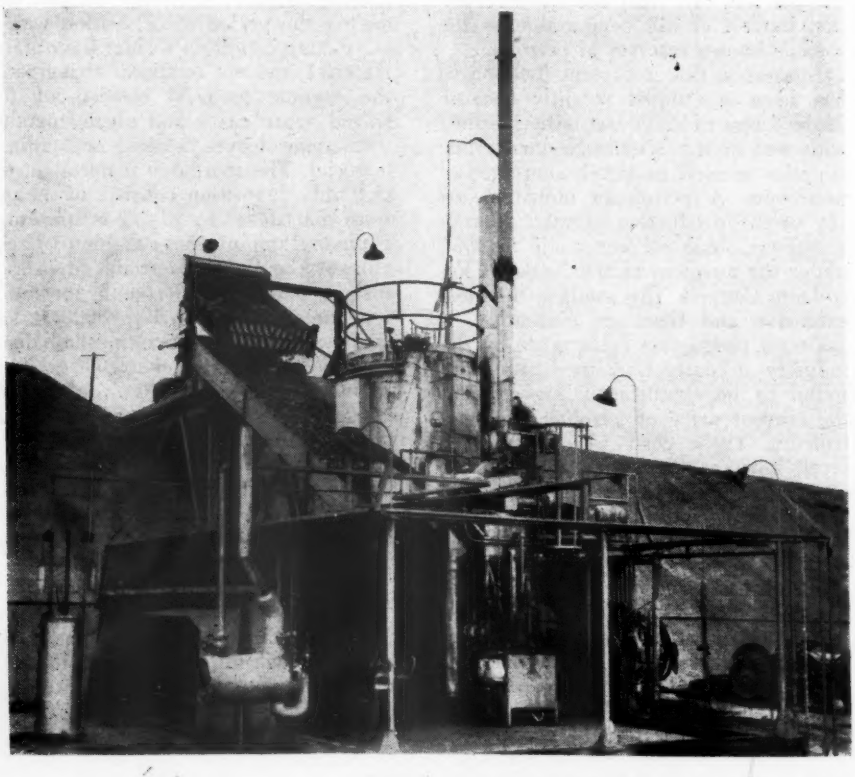
The retorting of shale requires an operation combining very good heat and fuel economy with low capital investment. A variety of retorts for shale have been developed,[5] however, in this particular area water is at a premium and should not be required for operation of the retorting units. The retorting operation also must be capable of handling a wide size range of shale particles as well as a wide range of shale characteristics in order to avoid screening and discard of appreciable quantities of shale. In order to meet these demands the Union Oil Company developed its novel underfeed retorting method, which was publicly demonstrated in a 50-ton per day unit in 1950.[6,7,8] Fig. 3 presents a photograph of this unit in action. This retorting unit employs countercurrent flow of shale and air in a kiln utilizing bottom feed of solids. The ash and clinkers are removed overhead and the oil drained from the bottom of the unit, cooled by countercurrent heat exchange by the incoming shale. The oil is distilled by a downward flow of heat supplied by combustion of the residual carbon on the shale clinker near the top of the kiln. The heat available from combustion of the stack gases far exceeds the power of the plant. Almost perfect heat exchange is obtained in the units as the incoming air is preheated by the spent hot clinker and the products of distillation are condensed on the cool, incoming shale.

Construction Detail of Retort

Details of the continuous Union Oil shale retort are diagrammed in Fig. 4. It will be noted that the unit employs a cylindrical kiln with a hydraulically operated underfeed mechanism. Movement of the granular shale is upward through the unit with overflow at the top. Clinkers are removed by a hydraulically actuated plow mechanism and fall into an ash disposal chute. The sections of the kiln expand gradually upward, minimizing restruction to movement. The shale kiln employs an externally finned retorting section with cowling to direct air flow over the fins and control shell temperature. A secondary stack draws the air through the cowling section. Cooling of the shale by this arrangement is designed to effect a maximum metal temperature of 750 F at the burning zone. A conical slotted section below the retorting section effects the separation of the oil and gas from the shale bed. A cooler surrounds this section and the gas is withdrawn from this by a roto-clone blower.

The feeding mechanism at the base of the unit is so constructed that any fines falling through the grate return to the feeding piston and are re-intro-

FIG. 3. Fifty-ton per day shale unit.



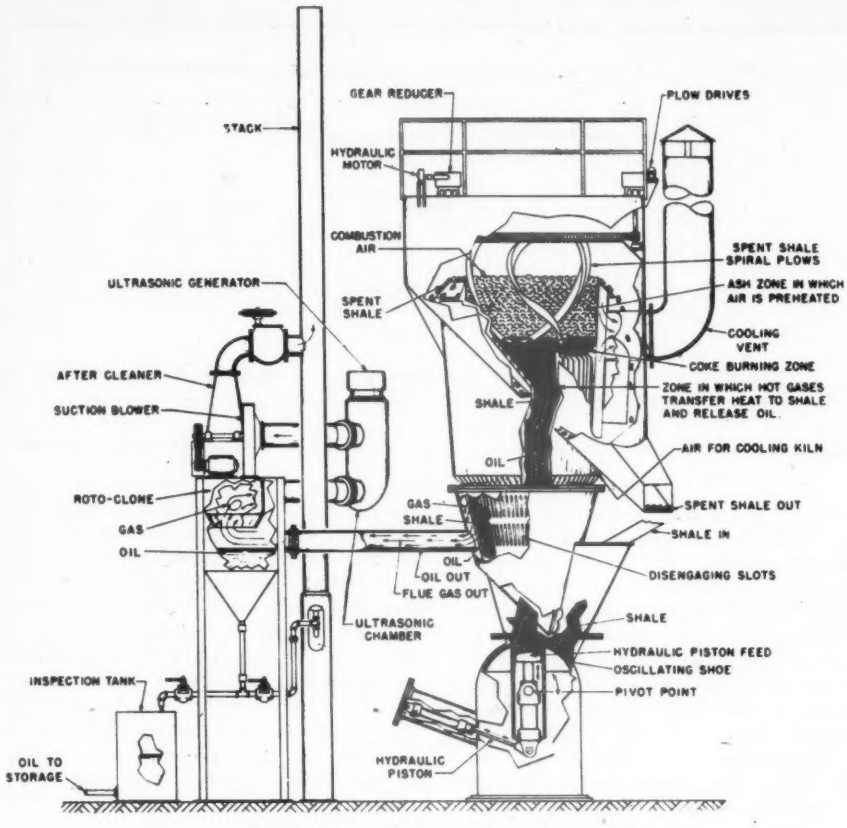


FIG. 4. Union Oil Company's shale retort.

duced into the unit. This prevents the gas and oil collecting housing from plugging due to accumulation of fines. The feeding mechanism is filled with oil to a level just below the slot edges, providing a liquid seal that prevents the blower from pulling air in through the feed hopper.

Operation of Shale Retort

Operation of the shale kiln is entirely automatic. The flow of air is controlled by an automatic flow control system. A temperature controller actuated by thermocouples at the shell of the retort maintains the burning section approximately 3 ft below the top of the kiln by control of the feeding mechanism.

The retorting section may be divided into three zones. In the top zone heat exchange between incoming air and hot clinkers is effected. In the lower portion of this top zone combustion of the carbon residue on the clinker is effected, producing flue gas with a temperature near 2000 F. This flue gas progresses into the second zone, termed the retorting zone, wherein the oil is educted from the shale. The mixture of shale oil vapors and flue gas progresses downward into the third zone, termed the condensation zone, where the incoming green shale is heated and the products of conduction are cooled and condensed. The temperature of the exit oil and gas from the kiln approaches within 20 deg of the shale being charged. A typical temperature profile of the shale kiln is graphically illustrated in Fig. 5.

It has been estimated that a typical commercial mine can produce approximately 20,000 tons per day of shale. The shale retorting plant designed to handle this production of shale will employ a battery of retorts, each having a capacity of 1000 tons per day of shale. In Fig. 6 is given the plot plan of a commercial retorting unit of this capacity. It will be noted that the gas handling system of this unit will be centralized as well as that of the hydraulic power supply equipment.

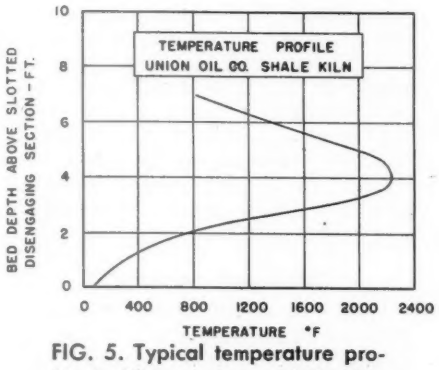


FIG. 5. Typical temperature profile in 50-ton per day shale kiln.

TABLE 1. Retorting plant performance.

Shale feed, tons/CD	20,000
Shale oil product, bbl/CD	13,125
Gas production (dry, total), MSCF/CD	270,000
Shale ash, tons/CD	12,500
Air rate to kilns, MSCF/CD	203,000

TABLE 2. Properties of shale oil.

Gravity, API at 60 F	20.7
Specific gravity at 60 F	0.930
Distillation (50 mm. vac.), F	
Initial	402
10%	536
20%	622
30%	692
40%	764
50%	814
60%	836
70%	865
80%	889
90%	Cracked
Water, per cent	0.1
Ash, wt. per cent	0.03
Conradson Carbon, per cent	4.57
Viscosity, SSU at 100 F	223
Viscosity, SSU at 210 F	46
Pour point, F	90
Sulfur, wt. per cent	0.77
Nitrogen, wt. per cent	2.01

Retorting Plant Performance

In Table 1 is presented yield data for a typical operation of a shale retorting plant processing 20,000 tons per day of shale averaging 30 gal per ton.

The shale oil produced from the Union type underfeed retort is characterized by relatively constant quality with little variation due to fluctuations in operating conditions. Typical properties of the shale oil are given in Table 2.

Of particular interest are the exceptionally low water and ash contents of this crude shale oil, averaging 0.2

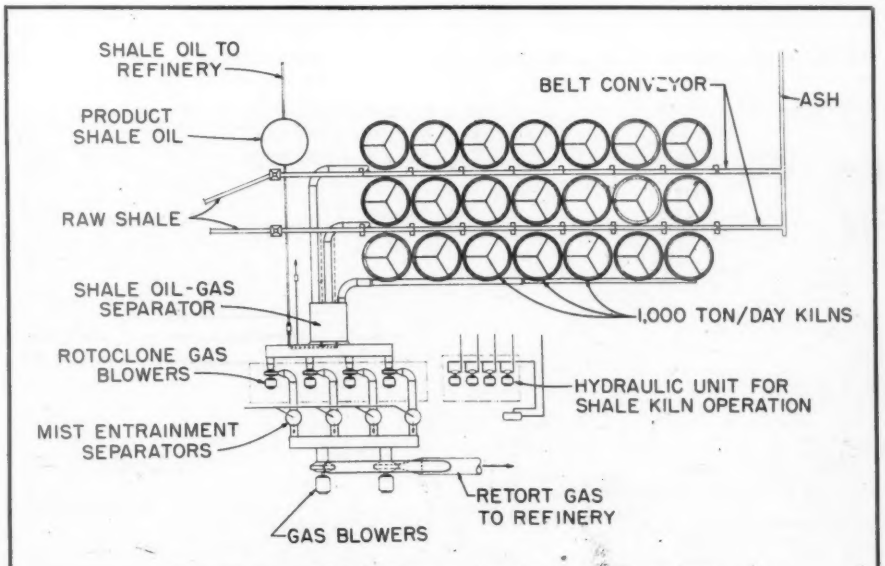


FIG. 6. Plan of 20,000-ton a day shale retorting plant.

TABLE 3. Composition of gas produced in retorting of shale.

Component	Mol %
Air	2.0
Nitrogen	57.5
Argon	0.6
Carbon monoxide	4.7
Carbon dioxide	29.7
Hydrogen	2.2
Hydrogen sulfide	0.1
Methane	1.0
Ethylene	0.6
Ethane	0.4
Propylene	0.5
Propane	0.2
Butylene	0.3
Butane	0.1
Pentenes	0.1
	100.0
Average molecular weight	32.44
Gross heating value	83.3 Btu/SCF

TABLE 4. Inspections of shale oil coker distillate.

Gravity, API	32.6
Nitrogen, wt. per cent	1.47
Sulfur, wt. per cent	0.74
Engler distillation, F	
Initial	172
10%	337
30%	440
50%	524
70%	582
90%	654
Nax	713
Rec.	98.0

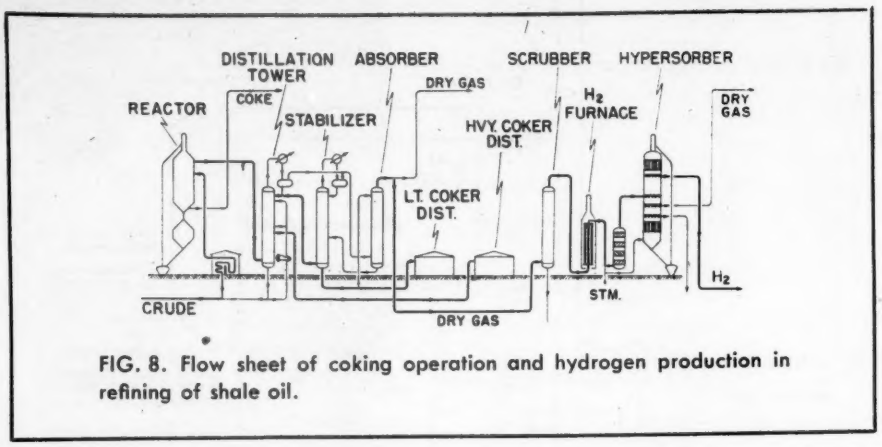


FIG. 8. Flow sheet of coking operation and hydrogen production in refining of shale oil.

weight per cent for the former and 0.003 weight per cent for the latter. Gas produced in retorting of Colorado shale amounts to 13,490 std. cu ft per ton and has the composition given in Table 3.

The ash produced amounts to 62.8 weight per cent of the fresh shale. Heat efficiency of the retorting operation is very high and the total energy requirements for operation of the retort amount to only seven per cent of the gas yield and less than two per cent of the energy value of the total retort production.

Location of Mines, Retorts, and Refining

In Fig. 7 is given a map showing typical location of the shale mines, retorts, and refineries that could be employed in a practical scheme of operations of the production of shale oil and refined products. The retorting operation effects a hydrocarbon recovery of approximately 100 per cent, based on weight of oil and hydrocarbons from assay of the shale. An important consideration in the over-all retorting operation is the high energy quantities available from combustion of the retort gas, amounting to approximately 25 per cent of the total energy available from the retorting of shale. This gas is vital to the refining step on shale oil. Transmission of the gas through large diameter low pressure drop conduits is a fundamental step in the over-all economy in the refining of shale oil. Without this important fuel source, approximately 20 per cent of the crude shale oil would be destroyed to provide power requirements necessary for refining. Through utilization of the gases from retorting, very high over-all yields of refined products from crude shale oil are maintained.

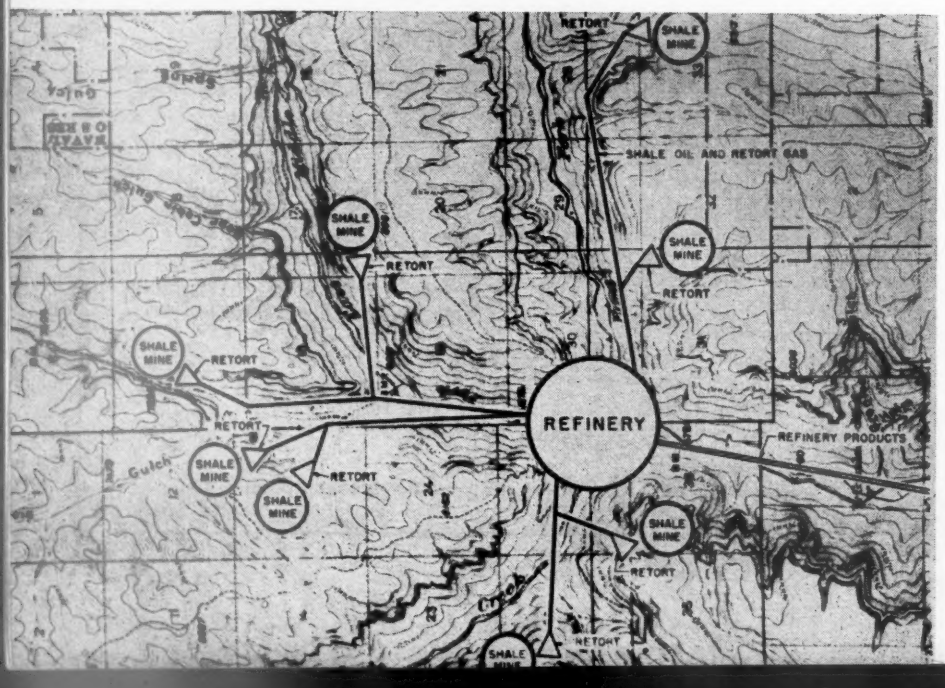
Coking of Shale Oil

As the first step in the refining of shale oil, it is necessary to adjust the boiling range to that consistent with fuels in volume demand. The continuous contact coking process developed by the Lummus Company[9] is particularly applicable to the coking of shale oil as the circulating granular coke charge can supply a major portion of the heat load for the coking operation and only a minimum amount of heat need be added to the liquid fuel charge of the rather reactive crude shale oil. An over-all yield of 79.6 volume per cent 700 F E.P. distillate can be obtained in the coking of crude shale oil. In Table 4 are presented the boiling range and inspections of the coker distillate.

Comparing the characteristics of the crude shale given in Table 2 and those of the coker distillate, it will be noted that although a substantial change in reduction in boiling range is effected only minor reductions in the nitrogen and sulfur content are effected.

In the course of coking of shale oil, substantial quantities of methane and ethane are produced which are utilized for the production of hydrogen by reforming with steam. This hydrogen is consumed in the subsequent refining steps. In Fig. 8 is given a flow sheet of the coking operation and hydrogen production carried out as the initial step in the refining of shale oil. It will be noted that the coker distillate is fractionated into light and heavy distillate, the light distillate being in the gasoline range and the heavy distillate being in the diesel range.

FIG. 7. Map of typical location of shale mines, retorts, and refinery.

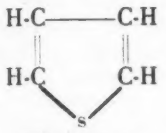


Cobalt Molybdate Refining of Heavy Coker Distillate

The upgrading of coker distillates of shale oil requires removal of organically combined sulfur, nitrogen, and oxygen as well as the saturation of highly olefinic and reactive hydrocarbons. This can be effected by catalytic refining by the cobalt molybdate process[9] in which the above contaminants are converted into hydrogen sulfide, ammonia, and water. Hydrogenation of the olefins in the stock occurs, but under the conditions normally used esesntially none of the aromatics present are hydrogenated. Conversion of the sulfur, nitrogen, and oxygen compounds to saturated hydrocarbons and inorganic by-products occurs by the cleavage of carbon-sulfur, carbon - nitrogen, and carbon - oxygen bonds. Essentially no carbon-to-carbon

TABLE 5. Reactions of various classes of compounds in cobalt molybdate refining.

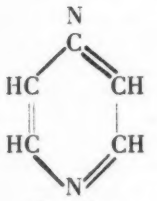
Hydrogenation of Sulfur Compounds



Thiophene + $4H_2 \rightarrow$ C_4H_{10} (Butane, isomers) + H_2S (Hydrogen Sulfide)

Hydrogen

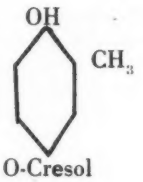
Hydrogenation of Nitrogen Compounds



Pyridine + $5H_2 \rightarrow$ C_5H_{12} (Pentane, isomers) + NH_3 (Ammonia)

Hydrogen

Hydrogenation of Oxygen Compounds



O-Cresol + $H_2 \rightarrow$ + H_2O (Water)

Hydrogen Toluene

Hydrogenation of Olefins

C_5H_{10} Amylene + $H_2 \rightarrow$ C_5H_{12} (Pentanes, isomers)

Hydrogen

bonds are broken. As an illustration of the nature of the reactions occurring during cobalt molybdate refining, the above reactions are presented in Table 5 illustrative of the various classes of compounds undergoing conversion.

Fig. 9 presents the flow sheet of a cobalt molybdate refining plant treating shale oil heavy coker distillate. It will be noted that before entering the catalyst-containing reactor of the cobalt molybdate refining plant the heavy coker distillate and recycle hydrogen are preheated by heat exchange in separate exchangers against the hot reaction products. The exothermic heat of reaction obtained in the treatment of coker distillates is of sufficient magnitude to make the process independent of appreciable furnace pre-heat requirements except during start-up periods. Hydrogen sulfide and ammonia in the recycle gas are removed by absorption at reaction pressure. Regeneration is accomplished by adding air to inert stream of combustion gas that is circulated over the catalyst by means of a blower. Inert gas for this purpose is generated by burning fuel gas in a special furnace. The product of refining in this operation meets the specifications of premium diesel fuel.

Cobalt Molybdate Reforming of Light Coker Distillate

Reforming of the light coker distillate is carried out by the cobalt molybdate refining process[11] employing somewhat altered conditions as a product of relatively high octane is required to meet specifications of premium motor fuel. By utilization of higher temperatures and lower pressures in the refining step, dehydrogenation of the naphthenes occurs simultaneously with the various other reactions outlined in the previously described plant. A substantial amount of isomerization and hydrocracking also occurs, which contributes appreciably to the premium quality of the motor gasoline products. In Fig. 10 is presented the flow sheet of the cobalt molybdate reforming plant producing premium motor fuel from light coker distillate from shale oil.

Products Obtained

The refining steps and techniques outlined previously for the upgrading of shale oil can lead to premium diesel fuel, jet fuel, and motor fuel. By carrying out the continuous contact coking of crude shale oil followed by cobalt molybdate refining of the full range coker distillate, approximately 85 per cent over-all liquid yield of premium high cetane diesel fuel and jet fuel is obtained. The sequence of these operations is presented in the flow sheets given in Figs. 8 and 9, and in Table 6 are presented the products derived in the refining of 10,000 bbl of shale oil by this sequence.

The stocks derived by this sequence of refining steps are directly useful as military fuels. For civilian use, however, it is desirable that a high octane motor gasoline be produced rather than jet fuel, and it is not essential to produce high cetane diesel fuel. To meet domestic requirements it is preferable to carry out continuous contact coking of the crude shale oil, as illustrated in Fig. 8; followed by cobalt molybdate hydrogenation of the heavy coker distillate, similar to Fig. 9; together with cobalt molybdate reforming of the light coker distillate, as illustrated in Fig. 10, followed by catalytic cracking of the hydrogenated heavy coker distillate and blending of gasoline

FIG. 9. Flow sheet of cobalt molybdate reforming plant for shale oil (mild hydrogenation).

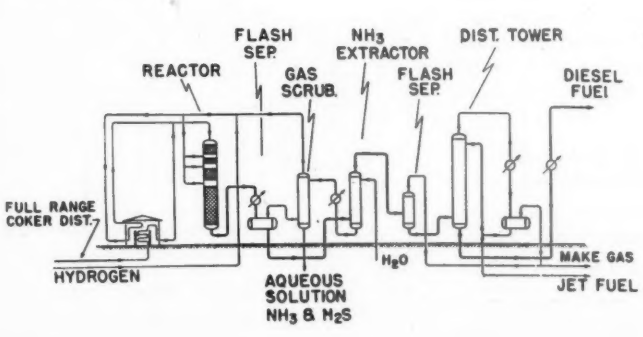


FIG. 10. Flow sheet of cobalt molybdate reforming plant for shale oil.

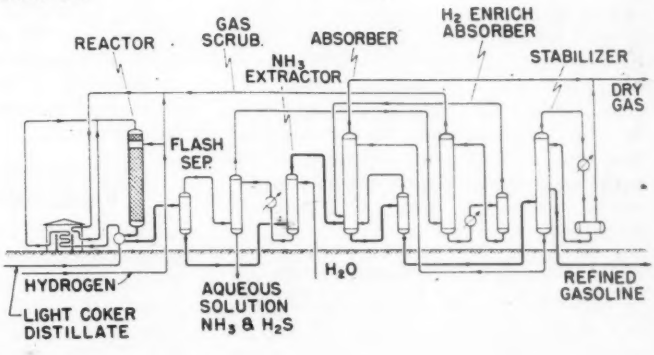


TABLE 6. Products derived from contact coking and hydrogenation of 100,000 bbl of crude shale oil.

Shale retorted, tons		152,300
Retort gas, MSCF		2,056,000
Ash, tons		95,100
Refinery gas, MSCF (1,060 net Btu/SCF)		51,000
Jet fuel, bbl	51,500	
Diesel fuel, bbl	33,500	
Coke, tons		2,360
Ammonia, tons		124
Sulfur, tons		86
Total liquid refined product, bbl	85,000	

Product data	Jet fuel	Diesel fuel
Gravity, API	51	37
Freezing point, F	—70	—
Bromine number	0.5	—
Sulfur content, wt. per cent	0.05	0.02
Nitrogen content	0.01	—
Cetane number	—	59
Pour point, F	—	5
Visc., SSU at 100 F sec.	—	39

TABLE 7. Products derived from refining 100,000 bbl of crude shale oil with contact coking, hydrogenation, reforming, and catalytic cracking.

Shale retorted, tons		152,300
Retort gas, MSCF		2,056,000
Ash, tons		95,100
Refinery gas, MSCF (1,060 net Btu/SCF)		50,100
Gasoline, bbl	50,700	
Diesel, bbl	26,050	
LPG, bbl	3,570	
Fuel oil	1,200	
Coke, tons		2,360
Ammonia, tons		184
Sulfur, tons		86
Total liquid refined product, bbl	81,520	

Product data	Gasoline	Diesel
Gravity, API	58	35
Sulfur content, wt. per cent	0.03	0.08
Nitrogen content	0.002	0.01
Pour point, F		0
Knock rating F-1, + 3 cc. TEL	90.5	
Cetane Number		47
Engler, 90 per cent point, F	345	610
Visc., SSU at 100 F sec.		36

TABLE 8. Inspections of feed and products in the hyperforming of Santa Maria light coker distillate.

	Feed	Product
Gravity, API	52.7	60.0
Engler distillation, F		
Initial	147	87
10%	192	131
50%	267	205
90%	342	328
95%	364	415
Max.	390	429
Sulfur, wt. per cent	3.47	0.035
Nitrogen, wt. per cent	0.020	0.002
Octane rating		
F-1, + 3 cc. TEL	80.0	94.5
F-2, + 3 cc. TEL	69.5	87.0

stocks in existing refineries near the population centers. In Table 7 are given products derived from refining 100,000 bbl of crude shale oil by this method. It will be noted that an over-all yield of 81.5 per cent in liquid products is obtained by this refining sequence and that the gasoline middle boiling ratio is 1.95, corresponding to the national average. Inspections of the products are equal to or better than those of conventional petroleum products currently marketed.

New Process Promises to Be of Value in Refining Shale Oil Stocks

A major advance in the refining of inferior grade stocks was made when the Union Oil Company announced the Hyperforming process.[12] This is a reforming and refining process that utilizes a moving bed of cobalt molybdate catalyst and that is suitable for the refining of high nitrogen, high sulfur gasoline stocks from shale oil, Santa Maria crude, and other inferior stocks. Typical of the refining ability of this new process are the inspections of feed and products obtained in the refining of high sulfur Santa Maria coker distillate and given in Table 8.

It will be noted that 99 per cent elimination of sulfur as well as 90 per cent elimination of nitrogen together with similar upgrading of 80 octane rating to 94.5 F—1, + 3 cc. TEL was effected by Hyperforming. Also of distinct interest is the 60 F drop in mid-point boiling range of the gasoline stocks by substantially increasing the volatility valuable for good performance in automotive engines.

Inferior Stocks Refined Without Hydrogen Generation

The Hyperforming process permits the refining of blends of straight-run gasoline and substantial quantities of high nitrogen, high sulfur distillates from shale oil and high sulfur crudes. The efficient exchange of hydrogen between the straight-run gasoline and the inferior stock permits refining without the requirement of outside hydrogen. In the Hyperforming operation the hydrogen liberated in dehydrogenation of naphthenes to aromatics is re-utilized within the reactor to eliminate large quantities of nitrogen, sulfur, and oxygen in the inferior stock. Olefins are saturated as well. The features of this process open the possibility of refining incremental quantities of shale oil in a refinery where straight-run gasoline stocks are available without the generation of outside hydrogen.

The Hyperforming process utilizes a moving catalyst bed of the cobalt molybdate type with a recycle stream of hydrogen. In Fig. 11 is given the assembly diagram of a commercial Hyperforming plant. It will be noted that circulation of the catalyst is effected by means of the recently developed mass flow solids moving principle which moves catalyst at low velocities without impact and with low attrition loss. Both the reactor and the regenerator utilize a moving bed. By the use of continuous reaction and regeneration in the catalyst cycle, a substantial economy in plant construction is effected and plant maintenance will be reduced over that of cycle processes. The usual limitations on end point do not exist in this process, and stocks boiling up into heavy gas oil range can be processed.

The Economics of Shale Oil Production and Refining

The economics of shale oil production have received considerable attention by the petroleum industry during the past decade. The volume of shale oil available from the mahogany ledge alone of the Picance Creek Basin amounts to over one hundred billion barrels of oil and is about three times the known petroleum reserves of the United States. Recent interest in this fuel source has been stimulated also by the possibilities of an all-out military effort, with high demands for crude oil production coupled with the possibility of loss of supplies from Middle Eastern crude in the event of such an emergency.

The rapid technological advances during the past decade have made possible the production of refined products from shale oil comparable in quality with those from petroleum. More recently, the technical advancements in shale oil processing have made distinct advances in reducing the cost of this over-all operation. In 1948 the Oil Subcommittee of the House Armed Services Committee[13] obtained figures in comparative cost of producing refined products from crude oil and shale (Table 9).

In the estimate it will be noted that the cost of shale oil, including 15 per cent charge on investment, would be 24.85 cents per gallon of gasoline. Steel requirement would be 7.4 tons per barrel per day and investment on the order of $9300 per barrel per day gasoline. In 1949 technological advances had progressed to the point where overall reductions in this estimate could be

FIG. 11. Hyperforming unit.

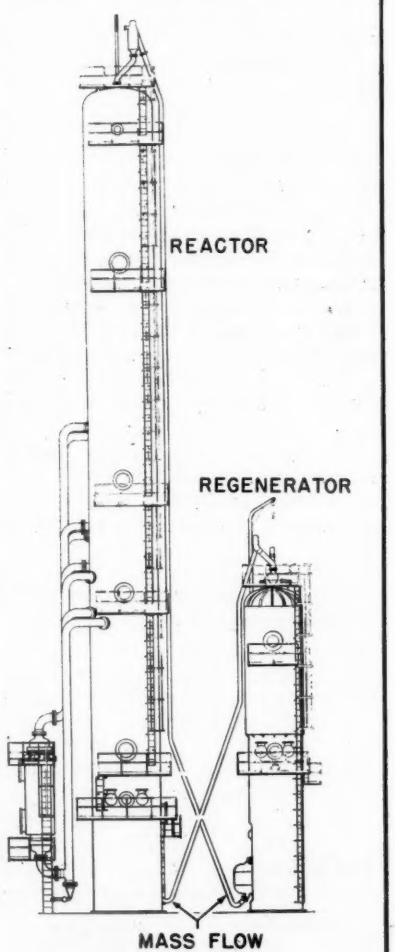


TABLE 9. 1948 shale oil cost estimate.

Statement by E. V. Murphree, Standard Oil Development Company to Oil Subcommittee of House Armed Services Committee, February 25, 1948.

	Crude oil	Oil shale
Investments		
For max. dist. yield, $/bbl/D oil prod.	4300	6300
For max. gaso. yield, $/bbl/D gaso.	6500	8400
Possible housing investment, $/bbl/D gaso. (max. gaso. case)	....	900
Steel requirements		
For max. dist. yield, tons/bbl/D oil prod.	5.7	5.7
For max. gaso. yield, tons/bbl/D gaso.	7.8	7.4
Per cent gaso. in liq. prod. (max. gaso. case)	87	87
Raw material price assumed or established	$2.78/bbl[1]	$1.00/ton
Gasoline costs (max. gaso. case)		
Raw material, c/gal	8.8	4.2
Manufacturing less credits, c/gal	4.3	11.8
Product transportation c/gal	1.0	....
Total, c/gal	14.1[1]	16.0
Added housing cost if required	....	0.6
Effect of increase in raw material cost	$1.00/bbl adds 3.2c/gal	$1.00/T adds 4.2c/gal
Effect of 10 per cent return		
On investment in manufacturing	1.6c/gal	....
Or, manufacturing plus mining	....	5.5c/gal

[1] These figures are based on crude oil and natural gas prices, not on their costs.

TABLE 10. 1949 shale oil cost estimates.

From "Liquid Fuels From Coal and Oil Shale" by George Roberts, Jr., and P. R. Schultz, Journal of Petroleum Technology, Vol. 1, p. 24, No. 9, September 1949.

Raw material	Oil shale	
Source	Colorado	
Company	Standard-Stanolind	Standard Oil Dev. Co.
Market	Midwest	California[1]
Investment/bbl of total product/CD (including raw material and transportation)	$9700	$8600
Raw material cost	$0.99/ton	
Gasoline cost (including 15% charges on investment)		
Raw material, c/gal	5.1	4.7
Mfg. and transp. less credits, c/gal	17.4	14.0
Total at market center, c/gal	22.5	18.7

[1] Data from paper by Murphree, Gohr, and Barr, A.I.Ch.E. regional meeting, Tulsa, Oklahoma, May 9, 1951[49].

made, and in Table 10 is presented an estimate on cost of shale oil for this period, prepared by petroleum industry experts.[14]

It will be noted that a reduction of two to six cents per gallon of gasoline over that of the 1948 estimate was effected by the latter half of 1949. Including 15 per cent charge on the investment, gasoline costs were calculated at 18.7 to 22.5 cents per gallon.

During 1951 a petroleum industry survey was made of the production of shale oil under the auspices of the National Petroleum Council. This study constituted the most extensive and thorough evaluation of shale oil made to date.[15] It also included a study of the hydrogenation of coal as a possible source of synthetic fuel. The work was subdivided among 47 industry men who were experts on synthetic fuel processes. Over 190 meetings were held, at an estimated industry cost of $300,000. The estimate of shale oil costs resulting from this study is given in Table 11.

TABLE 11. 1951 shale oil cost estimate.

Cost Estimate Prepared by National Petroleum Council Committee on Synthetic Liquid Fuels Production Costs, Announced by W. S. S. Rodgers, Chairman, October 31, 1951.

	Coal hydrogenation		Oil shale	
	Single plant	Multi plant (8)	Single plant	Multi plant (5)
Coal or shale, tons/CD	12,960	112,590	76,800	384,000
Products, bbl (42 gal)/CD				
Gasoline	19,490	163,830	25,380	126,900
Diesel fuel	.....	.....	12,200	62,360
Liquefied petroleum gas	6,390	52,170	1,780	8,920
Residual fuel	.....	.....	340	3,050
Tot. liquid fuels, B/CD	25,880	216,000	39,700	201,230
Coke, tons/CD	.....	.....	1,180	5,900
Fuel gas, 1060 btu/cu ft, 1000 SCF/CD	.....	.....	24,830	124,150
Chemicals				
Phenol, bbl/CD	229	.....	.....	.....
Cresols, bbl/CD	383	.....	.....	.....
Xylenols, bbl/CD	508	.....	.....	.....
Ammonia, tons/CD	.....	.....	92	460
Sulfur, tons/CD	.....	.....	43	215
Manpower, total incl. supervision and administration	5,900	53,800	3,420	15,750
Construction materials				
Steel, thousand tons	220	1,710	178	694
Steel, per daily bbl of prod., tons	8.5	7.9	4.5	3.5
Construction labor, man hr x 1000	51	355	26	123
Investment total, millions of dollars	533	4,074	333	1,518
Inv., dollars per daily bbl prod.	20,600	18,900	8,400	7,500
Cost of gaso. with 6 per cent return on investment after income tax, c/gal	41.4	43.5	16.2	14.7

It will be noted that in large-scale shale operations gasoline from oil shale is estimated to approach 14.7 cents per gallon, calculated on the basis of six per cent investment return after income tax. This is a substantial reduction over the earlier figures of 1948 and 1949 and is indicative of the important technological progress being made in solving the problems of utilizing this national resource. It must be pointed out, however, that all of these estimates have contemplated relatively low return for the capital invested and that difficulties might be encountered in raising capital at these levels of return.

As of October 1, 1951, the cost of gasoline at refinery or terminal bulk locations in the United States was in the range of 12 to 12.6 cents per gallon with premium grade approximately one cent higher. These costs of gasoline from natural petroleum are the prices against which gasoline from shale must compete. It is apparent that production costs of gasoline from shale are significantly higher. Cost levels, however, are such that production of oil from shale is our most attractive source of synthetic fuel and warrants continued attention by the petroleum industry. The possibilities and magnitude of the future development of oil shale will be affected by the trend in cost of gasoline from crude petroleum as well as future technological advances.

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15. Announcement by W. S. S. Rodgers, Chairman, National Petroleum Council Committee on Synthetic Liquid Fuels Production Costs, Washington, D. C., October 31, 1951.

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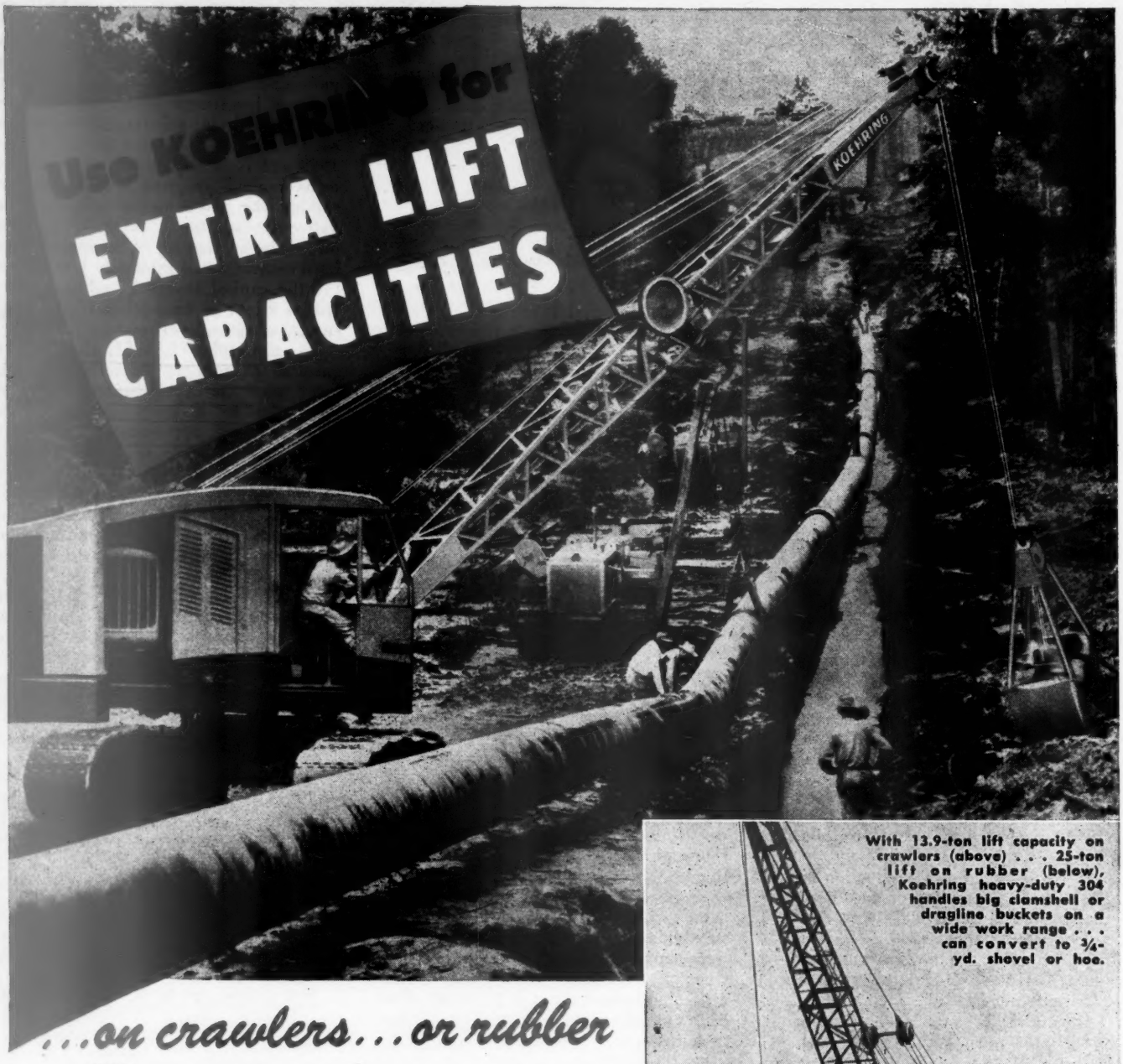

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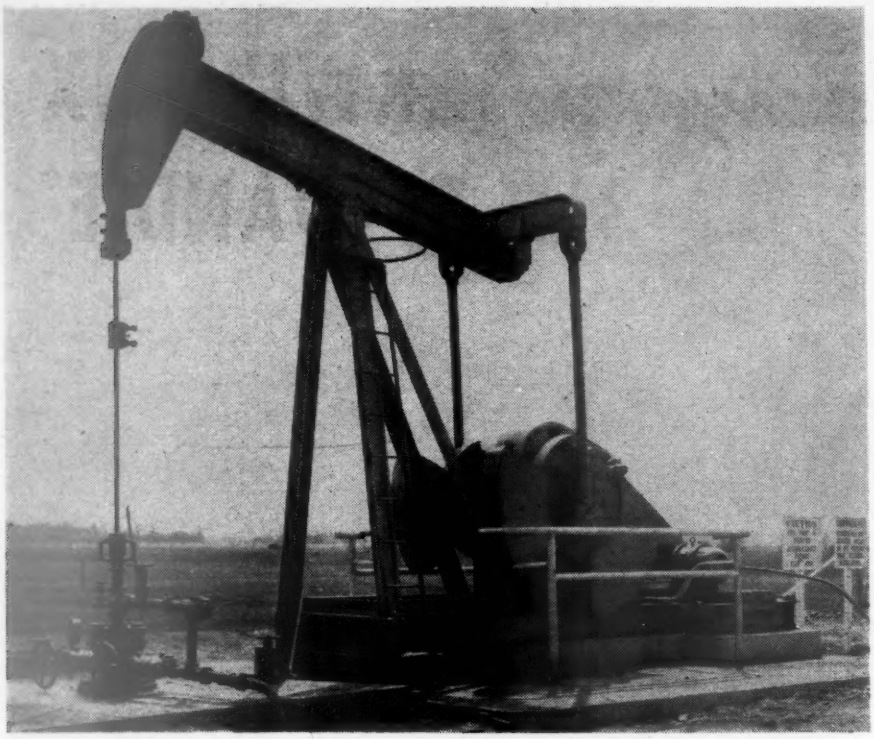


Typical Alberta pump installation. Okalta No. 9 well, South Leduc.

CANADA'S OIL YEAR

First discovery well in Williston Basin highlighted Canada's oil year, but refining dominated picture

LESLIE ORR ROWLAND*

TECHNICAL progress in Canadian oil industry operations in 1951 centered around refining, in which the introduction of new designs and overhaul of existing plants kept pace with the biggest year of construction volume in the history of Canadian refining expansion. Drilling problems have been negligible and attention of contractors throughout the year has been directed mostly towards raising the safety standard of rigs and enlarging the scope of education for crews and supervisory staff. Some new completion practices have been introduced to Canada for the first time, with varying degrees of success. Pipe line activity has been limited to construction of new pumping stations on the Interprovincial line and the commencement of two products lines in Quebec and Ontario, none of which has presented unexpected developments except in a favorable sense.

A furious rush of activity into southern Saskatchewan during 1951 was stimulated by discovery of light crude oil in southwestern Manitoba at the Virden wildcat strike of California Standard Company, operating subsidiary of Standard Oil Company of California. The first wildcat in the area, but fourth for the company in a drilling program that started in 1950 in Manitoba, Cal-Standard Daly No. 15-18, lsd 15 18-10-27WPM, drilled to 5305 ft, plugged back to 2340 ft and set casing at 2200 ft at top of Paleozoic limestone. Swabbing tests run over a three-day period at the end of January yielded a flow of about 3 bbl per hour of approximately 35 API gravity crude oil with 30 per cent water cut.

Development to the end of November had consisted of three additional producers. The discovery well and an offset, both capable of producing at greatly diminished amounts from original swab flow, are shut in for winter as being uneconomic. Two producers situated about four miles southwest are pumping at about 40 and 25 bbl daily, production being trucked to a small refinery at Kamsack, Saskatchewan, 150 miles northwest of the field. Five development rigs are at work on evaluation stepouts, but at end of November results were negative, with one abandoned and four current drillers. Two wells were waiting for cable tool rigs to complete, on account of tight porosity with danger of sealing off by drilling mud if drilled into the prospective pay zone with rotary rigs. One well was on pump test. The field is tentatively defined as about five miles north and south and three miles east and west, with variable porosity and permeability.

Significance of the discovery was that it preceded by several months the discoveries in North Dakota and Montana and thus was the first discovery in the Williston Basin. Drilling in Saskatchewan, and geophysical activity in that province, have leaped to new high levels, largely as the result of the discovery, and approximately a dozen wildcats have been drilled in the area close to the border, while geophysical crews at work have increased from about 10 at the end of 1950 to 45 in November of 1951, most of the new crews being assigned to that area. Principal companies holding exploration rights from the Government include Sohio Petroleum Company (operating subsidiary of Standard Oil of Ohio); Shell Oil Company; Albercan Oil Corporation (subsidiary of Canada Southern Oils Limited); Western Prairie Exploration Company Limited; Canadian Devonian Petroleums Limited; and Tide Water Associated Oil Company. Both Sohio and Tide Water operate for a number of other companies.

No discoveries have been made in the Basin area of Saskatchewan, but the team of Albercan Oil Corporation and Royalite Oil Company Ltd., has made an important discovery of heavy crude, about 18 API gravity, at Coleville, some 100 miles south of the Lloydminster-Lone Rock oil fields. Development consisted of six producers at the end of November, with five rigs working on stepouts.

Alberta discoveries during the year were fairly numerous, nearly all in the central plains area between Leduc and Drumheller, and no evaluation can yet be made of the dozen or more pools which include Devonian coral reef, limestone, Lower Cretaceous Sand and Viking Sand as their producing formations.

In the overall picture of Canadian progress during the past year, the most significant composite event has been the greatly accelerated approach to integration, on balance at least, between domestic production and refining capacity and the total consumption of products. During the summer crude oil output reached a new high of 168,449 bbl per day average for the month of August, from Alberta fields, and total production will exceed 44,000,000 bbl for the year, an increase of some 55 per cent over the

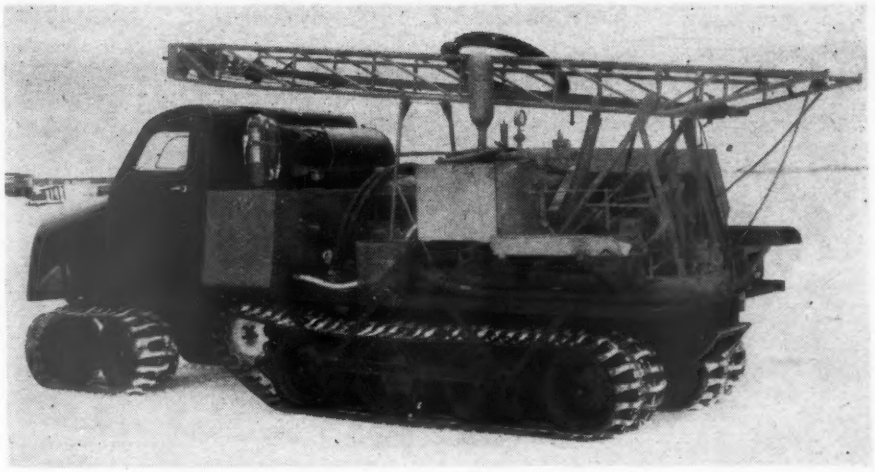
*Editor, Oil in Canada.

EXCLUSIVE

1950 total of 28,600,000 bbl. The prairie region of western Canada, comprising Manitoba, Saskatchewan, and Alberta, became completely self-sufficient this year for the first time, with total refining capacity comfortably ahead of maximum demand, and crude production moving into a new market area at the Great Lakes at a maximum rate of just under 60,000 bbl per day. On the west coast and in Ontario, however, crude was still being imported, in smaller quantities than the previous year, and product imports were greater, pending completion of more refining capacity. Quebec continued to be supplied entirely with foreign crude to the extent of about 140,000 bbl daily at the peak, and the Maritime Provinces were also exclusively dependent on crude imports.

Construction of product lines eastward from Sarnia, Ontario, and westward from Montreal, Quebec, (commenced this year) to a marginal point at Toronto, will reduce seasonal dependence on imported products in 1952, and the going on stream of substantial increases in Ontario refining capacity should cut the actual amount of product imports.

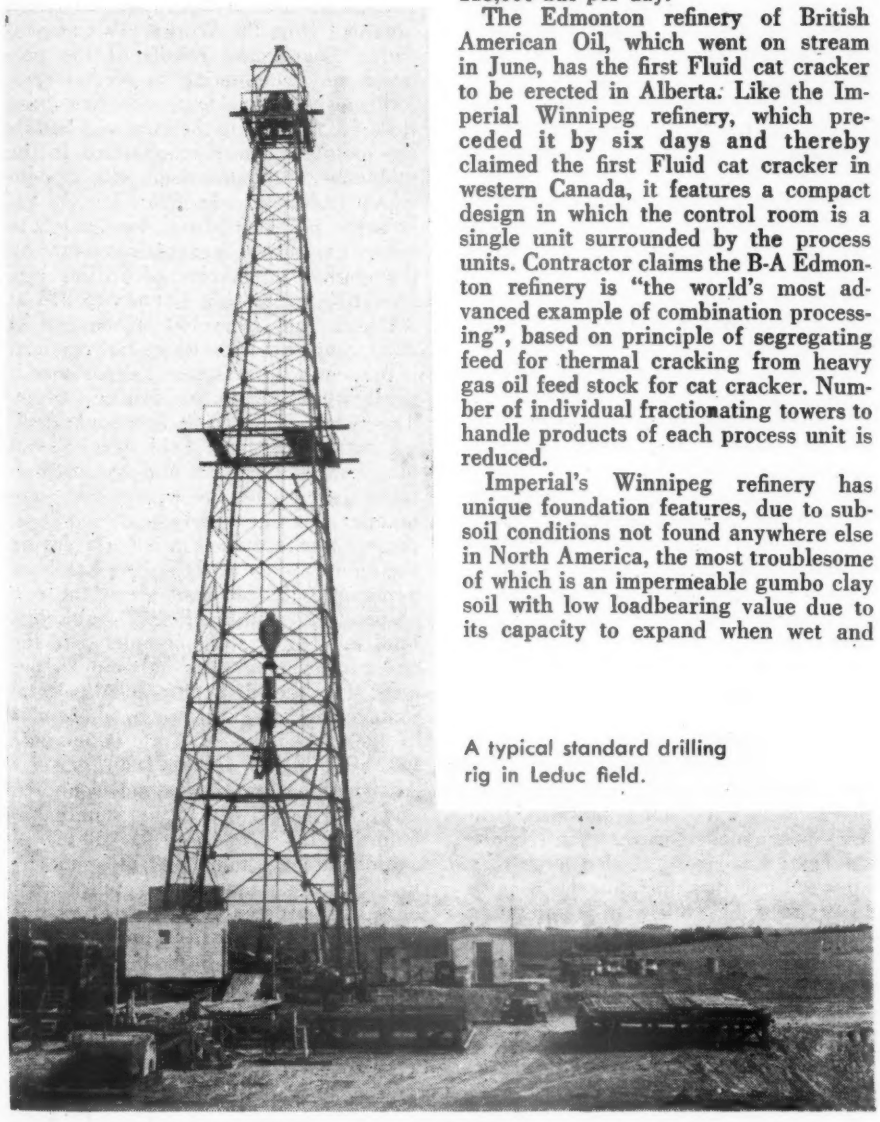
In western Canada, refinery capacity of 14,000 bbl per day at Winnipeg, and 11,000 bbl per day at Edmonton, in the form of new plants going on stream, were added during 1951. Improvements and additions to existing plants at Regina and Saskatoon, Saskatchewan, increased capacity by 4100 bbl per day. Total capacity at the year end was 118,000 bbl per day.



Seismic shothole drilling rig mounted on bombardier snowmobile chassis.

The Edmonton refinery of British American Oil, which went on stream in June, has the first Fluid cat cracker to be erected in Alberta. Like the Imperial Winnipeg refinery, which preceded it by six days and thereby claimed the first Fluid cat cracker in western Canada, it features a compact design in which the control room is a single unit surrounded by the process units. Contractor claims the B-A Edmonton refinery is "the world's most advanced example of combination processing", based on principle of segregating feed for thermal cracking from heavy gas oil feed stock for cat cracker. Number of individual fractionating towers to handle products of each process unit is reduced.

Imperial's Winnipeg refinery has unique foundation features, due to subsoil conditions not found anywhere else in North America, the most troublesome of which is an impermeable gumbo clay soil with low loadbearing value due to its capacity to expand when wet and contract when dry. Cedar telephone poles 40 ft long were driven into the ground to their full height as piling under all foundations, going down to the 2½ ft layer of "hardpan" below the clay. Design features a "straight line" pattern from crude to product tanks through process units to minimize interconnecting piping and reduce exposure hazards of sub-zero winter weather. Unhoused pumps have yet to stand the test of their first winter.



A typical standard drilling rig in Leduc field.

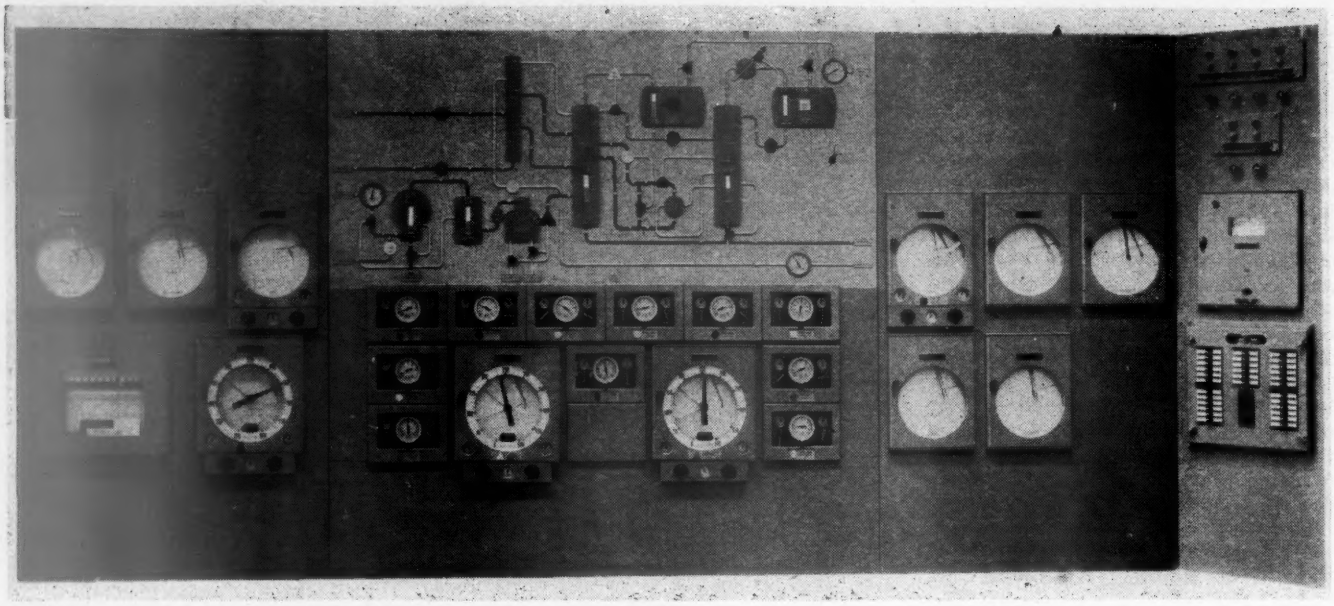
Among the notable examples of the rapid trend to high efficiency and simplicity in refining operations, the Imperial Winnipeg refinery contains in its control room what is probably the first "Color-Grafic" control panel to be installed in Canada. Manufacturer Minneapolis-Honeywell Regulator Company designed and installed the panel.

Principal original feature of the panel is its use of visual diagrams to give a complete flow picture of the portions of the refinery controlled by each section of the board. Four divisions are used: Atmospheric distillation unit; vacuum distillation unit; catalytic cracking unit; and gas recovery unit. Although flanking the unit diagram with relevant instruments interrupts the flow lines between the four sections, it affords the advantage of removing need to use the lowest portion of the board, hence makes for easier and quicker reading.

All the control instruments are "compact indicating controllers" identified by color in relation to their points of application on the flow diagram. Each variable under control is represented by a different symbol, and the color of the symbol identifies the point of application. One particular effect of this eye-saving color coding was to curtail operators' training time.

Charts and scales required for the various instruments are dated and coded in advance of use, and after completion are forwarded to the cost accounting department for recording and filing by code numbers.

Co-ordination of the entire network of instruments, including both recording and non-indicating controllers, is se-



Brown color graphic panel, Winnipeg refinery, Imperial Oil Limited.

cured from the single control point and thus an integrated control system is constituted which regulates accurately all critical process variables throughout the refinery.

Accomplishment of increased throughput has been accompanied by higher standard of safety and protection for plant personnel. Manufacturer quotes as an illustration the unique interlocking control system maintaining differential pressure between reactor and regenerator in the Fluid cat cracker, removing any danger of reverse flow. Operative medium is a compact indicating controller unit across the spent catalyst slide valve to control air supply to the catalyst level controller in the regenerator. Feed gas supply to the crude heater is also safety-regulated for the contingency of a pressure drop that would result in extinguishment of the burner flame.

Imperial-Winnipeg design was developed by the company's own engineering and development division. B-A Edmonton and McColl - Frontenac - Edmonton were both designed by the contractors, respectively Canadian Kellogg and Foster Wheeler. The McColl plant has added the third Fluid cat cracker to be installed in western Canada in a single season.

Addition of an enormous Fluid cat cracker to Imperial's Edmonton refinery introduces a Standard Oil Development Company design that is said to be the height of simplicity and efficiency and "first of its kind in the world." Work began this year for completion next summer.

In Ontario, Sarnia and vicinity are the scene of expansion which will raise total capacity in the area by 45,500 bbl per day and Fluid cat cracking by 43,250 bbl per day. Canadian Oil Companies Limited started construction in 1951 on a 20,000 bbl per day plant to have 10,000 bbl per day Fluid cat capacity, Orthoflow design by Canadian Kellogg, and the first U.O.P. Platforming unit in Canada of 3800 bbl per day capacity. Sun Oil Company, building its first Canadian refinery, started work on a 10,000 barrel plant with an equal capacity Houdriflow cat cracker. General contractor is Catalytic Construction Company. Biggest job of all is Imperial's addition of 15,500 bbl per day that will raise capacity of its Sarnia plant to 71,000 bbl per day, making it the largest in Canada. Canadian Kellogg, general contractor, will also install a simplified cat cracker of 23,250 bbl per day capacity, the largest in Canada.

Through continuous efforts of the Canadian Association of Oilwell Drilling Contractors, courses have been instituted both for education in drilling methods and technology and for training safe practices of rig operation. Mud schools, gas metering schools and oil emulsion schools gave instruction to a total of more than 300 crew members, and 450 men attended supervisory training conferences numbering 177 meetings in the field with supervisors. Mud schools have been held in both Calgary and Edmonton, for convenience of those attending.

Toolpusher institutes were held at three locations, under direction of Frank Carson of University of Texas, and attendance numbered a total of 62, representing very concentrated work in a specialized field. As the year closed, engine schools were being organized and plans being made for pumping schools. Financing has been provided largely by a few of the contractors, but the Alberta Government has this year co-operated with a generous grant. This fund will be applied specifically for detailed supervisory training to 12 rigs individually, at conference meetings to be held every six months.

Objective of all this work has been to improve basic safety factors which contractors realize are essential to profitable operation, and to impress crews, many of whom are very green on the job, with the reason for safety precautions. Excellent co-operation has been obtained from the Workmen's Compensation Board, and results of the program, now completing its second year, indicate that accident rate has been lowered. "Handling the men who handle the tools" has been emphasized in the toolpusher institutes, dealt with as education in human relations.

These programs have done much to lessen the obvious hazards attendant on the increase in number of drilling rigs operating in western Canada to 215 at the year end, from 140 at the end of 1950. Employment of domestic crew men is the regular practice, and experience is negligible owing to this fast expansion. The swing of emphasis to wildcat drilling and away from field development has been pronounced, and has precipitated the rush of new rigs to take care of operations at widely scattered locations. Footage drilled in Alberta during the months since early spring has been as much as 50 per cent above the corresponding month of 1950, although total number of wells completed to the end of November was only up 25 per cent. (In the first nine months total footage increased by one third, from 3 to 4,000,000 ft and the rate of increase has been higher in the last quarter.) Abandonment ratio was much higher, due to increased wildcatting, standing at 325 dry holes to 714 oil producers, against 197 dry holes for 673 producers in 1950's first 11 months. Total number of wells completed in the first 11 months was 1,136 as against 907 for the same period of 1950. In Saskatchewan some 75 new development oilwells were expected to be on production by the year end, and 70 dry wildcats abandoned.

Largely as a result of the Alberta Government's policy statement on nat-

ural gas in the fall of 1950, intimating that export permits would be considered as soon as reserves reach a size assuring protection for domestic consumers, drilling specifically for gas assumed much greater proportions. During the first 11 months of 1951, 66 potential gas wells were capped in discovery and development areas, awaiting markets, and 25 others were placed on production in proved fields. Comparative figures for the same 1950 period were 19 and 18.

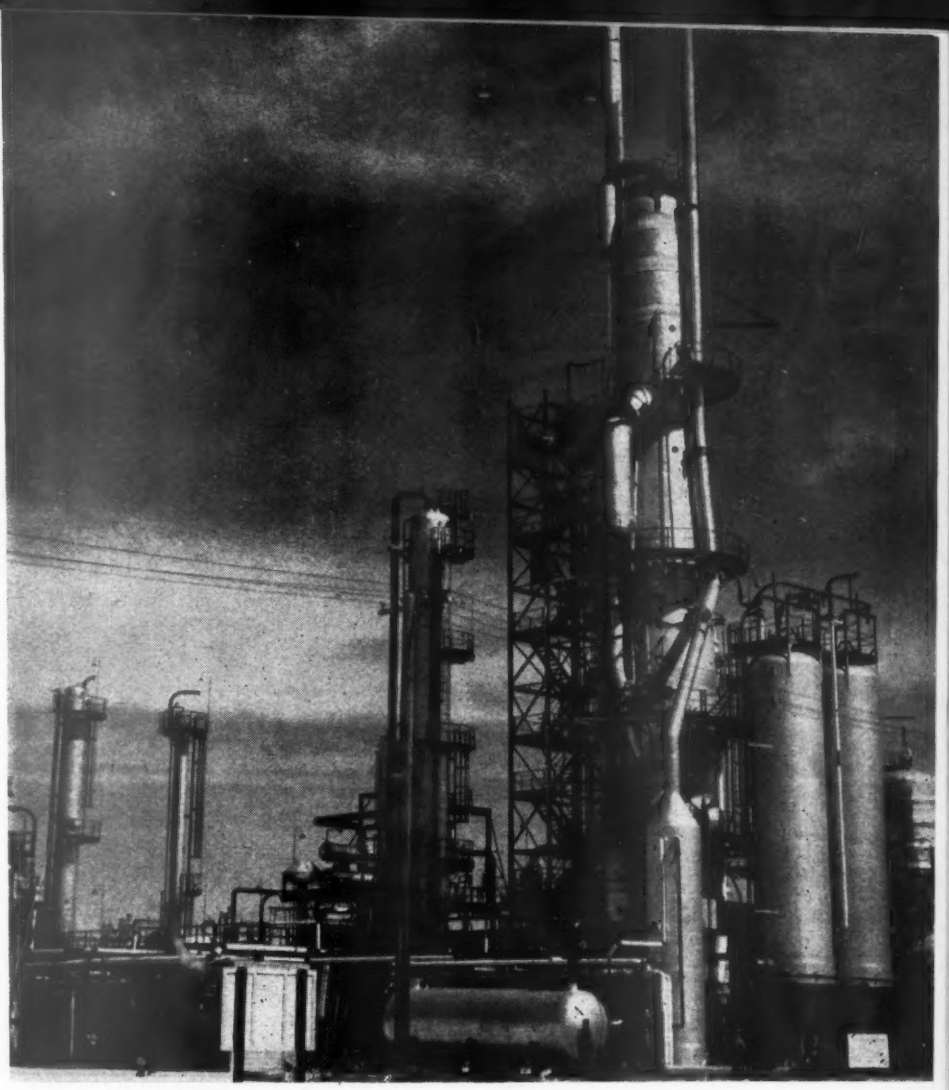
As a result of this extensive drilling, as well as gas shows in wells drilled for oil, reserves have increased to an amount cautiously appraised at eight trillion cubic feet. Among the significant discoveries of gas was the largest wet gas well ever drilled outside the Rocky Mountain foothills belt, Bailey Olds No. 1 about 40 miles north of Calgary, which is rated at 50 to 75,000,000 cu ft per day, 400 bbl of naphtha and high sulfur content that may be of value as a by-product. Brake horsepower is 3525 psi and completion depth 8124 ft in D2 zone of Devonian. Seismic data are said to indicate a substantial possible productive area.

Additional geological data and seismic interpretations done on the big Pincher Creek wet gas field structure have confirmed previous conservative estimates of 17,250 acres productive area and 1320 billion cubic feet reserves. No definite closure has been found at either the north or the south end, so that company engineers believe the pool area may be considerably larger. Floyd L. Gray, vice president of Gulf Oil Corporation, which owns the field, stated to the Conservation Board hearings in September that widely spaced locations of the three producers so far completed, and uniform well-to-well characteristics of the reservoir, "lend assurance that future wells will have deliverability on the order of routine production at 20,000,000 cu ft per day."

At the year end it appeared very likely that the Pincher Creek field will be Canada's first export supply area, as Gulf had signed a contract with Northwest Natural Gas Company for the entire field on a 20-year term, subject only to the latter company obtaining the necessary permits from the Alberta Government and the dominion Board of Transport Commissioners. Despite the presence of applications from four other companies before the Board, competent opinion supports the Northwest line from Pincher Creek to the Pacific Northwest market area, with top capacity of 165,000,000 cu ft per day.

Production from the Redwater oil field in 1951 reached new heights exceeding 100.000 bbl per day for several months, and brought forcibly to operators' attention a problem which had been under casual discussion for several months. This problem is the rapid bottom hole pressure decline due to the fact that the only natural drive mechanisms are gas in solution and a small water drive. Echometer surveys were run during the late summer on a large group of representative wells, and confirmed brake horsepower drop of one pound per 128,000 bbl of oil produced. Water-oil ratio is increasing rapidly and the bubble point of gas in solution would be reached about the middle of next summer at expected production rates, if no steps were taken to install secondary recovery methods. At that stage, water replacement would provide for production of only about 26,000 bbl per day for more than 900 wells. A pool operators' engineering committee has decided on a large water flood project to maintain pressure through injection wells drilled along the crest of the structure and supplied from the North Saskatchewan River which flows through the southern portion of the field. All wells will then be withdrawn from pump except fringe wells, and pumping will be resumed only as the rise in the water table makes this necessary, working in from the fringes. Saving in pump cost is estimated at over $1,000,000 by the third year of flooding. A full report is due early in 1952, by the engineering committee, and meanwhile no decisions have been made on technical details other than the broad features of the plan.

Some operators have expressed the opinion that the project will raise recoverable reserves by 10 per cent, which would result in net recovery of some 30 to 40,000,000 bbl above the 300 to 400,000,000 estimated recoverable. Field cumulative production to the year end was approximately 38,000,000 bbl.



Cat cracker at Imperial Oil Winnipeg refinery.

Eastman Oilwell Service introduced to Canada late in the summer a new completion practice for wells in the Coutts-Milk River border area of southern Alberta, consisting of directional drilling at close to a right angle into the tight producing formation to permit drainage from a larger formation surface. As a result of "sealing-off" problems with drilling mud in this area, one method of using a cable tool rig to drill into the formation had been resorted to earlier in the year, with fair results. No report on the Eastman "drainhole" completion method was available at the year end.

Also inconclusive was the use of Hydrafrac treatment, which had its first Canadian application in the Virden (Manitoba) oil field of California Standard Company in the summer. Designed by Halliburton, the operation consists of hydraulic fracturing by a highly viscous fluid in small volumes where formation is not susceptible to acid treatment. Granular material such as sand is used for a propping agent to accomplish the fracturing.

Exceeding its rated capacity by 12,000 bbl per day, the Interprovincial

pipe line has handled as much as 107,000 bbl per day through its pump station at Kerrobert, Saskatchewan, 219 miles west of Regina, at outgoing pressure of 1000 psi through 20-in. pipe. Total transmission of crude through the line in its first full year of operation has been approximately 46,000,000 bbl, of which about 12,500,000 has moved beyond Superior, Wisconsin, down the Great Lakes and an additional 2,000,000 has been used to fill the line and terminal storage. The terminal storage has been increased to 4,400,000 bbl to provide for a smaller fluctuation between winter and summer flow through line.

Owing to paraffin content of Alberta crudes, scrapers have been used with satisfactory results to keep accumulation off the inside walls of the pipe line. Otherwise adherences would increase friction and slightly decrease inside diameter, with loss of throughput volume or increase in discharge pressure for a given throughput. Batching plugs have also been used as scrapers. Scrapers are taken from the line at each pump station, cleaned and returned by express to the next upstream station. Dispatching office controls scraper insertion and notifies downstream station of expected time of arrival.

In the field of government control of scarce commodities, Canada in 1951 embarked on an allocation program for oil country tubular goods and other items involving steel. Set up under the dominion department of trade and commerce (with which defense production is closely affiliated), a new petroleum division was created in March. Its four sections deal with refining, producing, material, supply, and transportation. Unlike PAD's allocation, which amounts to only a "hunting license", the Canadian allocation program involves stockpiling the actual goods and allotting them according to priorities on orders from users which must be placed in advance for each quarter.

There have been virtually no complaints, and no drastic scarcity has been felt by operators, as evidenced by the great increases in well footage drilled, larger number of geophysical parties at work (150 compared to 117 a year ago), and refinery construction. Line pipe has not been a problem yet, but supplies have had to be secured from England and Scotland for the relatively small jobs started in 1951. A major switch in proportions of geophysical crews has taken place with developments in Saskatchewan, where 45 parties are now working, while a year ago there were only a dozen. Alberta's crews have remained stationary at about 100.

New tax legislation brought down in April exempted almost the entire oil industry from drastic measures deferring depreciation writeoffs for four years on new capital expenditures, as a means of saving construction materials, especially steel. As a further concession to the oil industry, a new regulation was passed in June, permitting the minister of trade and commerce to grant a certificate of eligibility for immediate depreciation allowance where an eligible taxpayer purchases an unrelated vendor's business and depreciable property which would have been entitled to depreciation before the change in April. If the vendor has acquired assets since that date, of course the new assets will be excluded from eligibility.

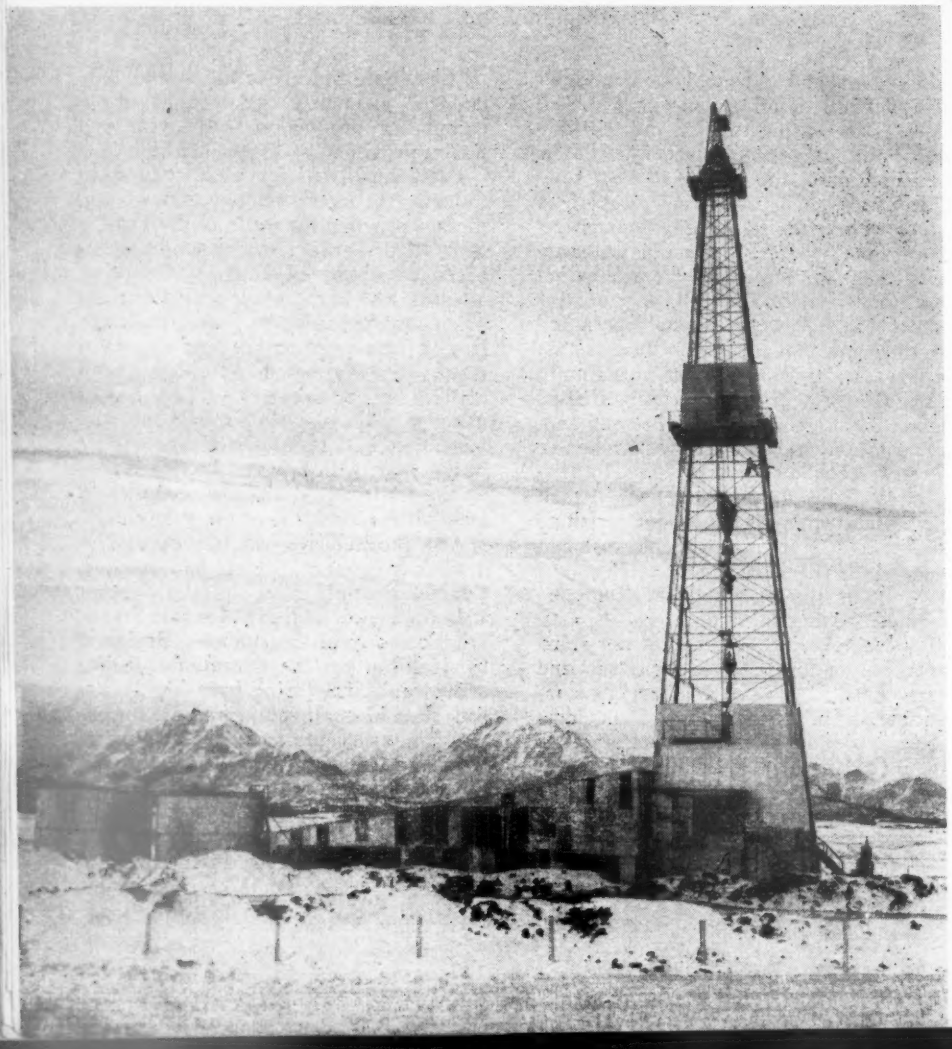
Of great importance to companies engaged in exploration and production, a new Foreign Exchange Control Board regulation passed in the fall permits applications by Canadian companies for United States funds to make investments in oil properties in the United States. Where substantial amounts are involved, American financing may be stipulated, but one Canadian company has already been given approval for a million-dollar program in the Williston Basin area to be financed entirely through its own resources. Interpretation of this relaxing of control is that Canada's foreign exchange position in relation to the United States has become much better, as indicated by recent firming of conversion rate to 3½ per cent.

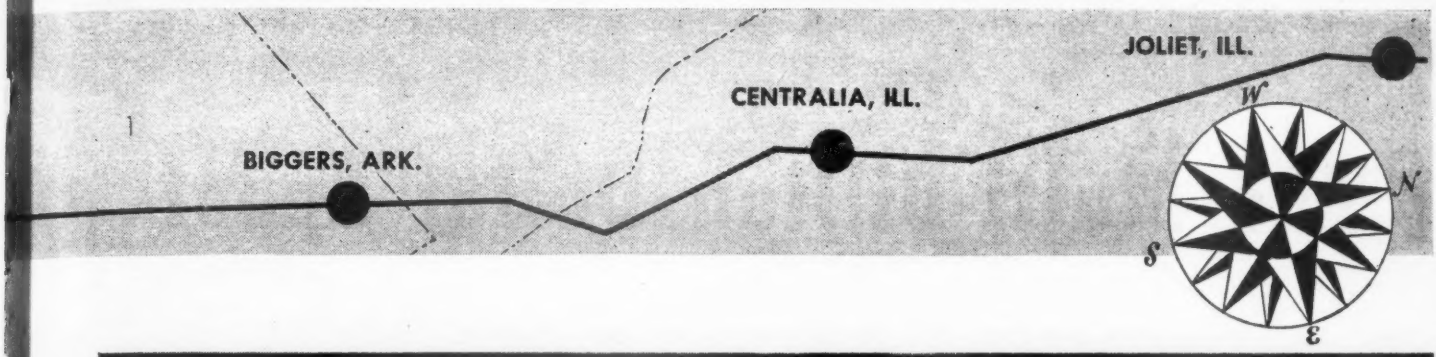
Requirements of controlled materials for 1952 first quarter were estimated in November, and amounted to 89,317 tons of steel, 672,000 lb of copper and copper alloy, and 49,000 lb of aluminum. Casing, tubing, and drill pipe is estimated at 18,000 tons, of which 10,000 tons will be alloted directly from the United States. Last quarter allotment, pursuant to an estimate of 18,000 tons, was 14,200 tons. No concern is felt by drilling contractors about their ability to continue increasing volume of footage despite this fairly stiff limitation, and one supply company executive recently forecast that at least 240 rigs will be working in Canada by midsummer against 215 at present.

Well completions for 1951 appeared at the time of writing to be falling far short of the 1500 forecast by the Western Canada Petroleum Association at the beginning of the year, for an indicated total of around 1400 for Alberta, Saskatchewan, and Manitoba combined, but up about 25 per cent over the 1100 completed in the three provinces in 1950.

* * *

In the shadow of the Rocky Mountains, south of Pincher Creek in the southwest corner of Alberta, Canadian Gulf Oil Company is developing Canada's largest "wet gas" field. A $250,000 research project, to determine best operating materials and methods, is now underway. A heavy duty National 125 rotary rig, capable of 14,000-ft drilling, is now putting down Gulf's fourth "million dollar well." That drilling by Parker Drilling Company is pictured below. As soon as gas market is made available, more than $20,000,000 will be poured into speeded-up development and construction of gas processing, condensate, and sulfur-extraction plants, and Pincher Creek will become an important new Alberta industrial center.





Worthington 2,000-h.p. 10-cylinder engine-compressors at New Caney, Texas, station of the new Gulf Coast-Chicago pipeline of the Texas-Illinois Natural Gas Pipeline Company. These engines used Worthington's uniflo thru-scavenging system —a design thoroughly proved by years of research by Worthington.

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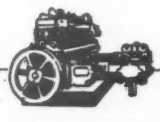
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WORTHINGTON

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The Multi-Billion Dollar Spoof†

We are told the government can do a project better than individual enterprise — and then we find out it never has — how long will we go on being spoofed?

ERNESTINE ADAMS*

THE word "spoof" was the name of a game invented by an English comedian. It was based on deception, as poker sometimes is, and it implies that the spoofer is trying to fool somebody who already half knows he is being made game of.

For instance, just a few weeks before the last presidential election Texas was reassured about holding its tidelands by both Attorney General Tom Clark and President Truman although California had already lost its marginal sea. Soon after Texas gave Truman the largest majority of any state, the Attorney General sued Texas for its tidelands and got them.

Now the presidential candidate had already approved the Democratic platform, which advocated federal control of all tidelands, so Truman could reasonably expect Texans to know he was just spoofing when he pretended they were safe from federal acquisition.

Senator Johnson called it double talk when the Defense Department, instead of admitting arms shipments to Europe were lagging, changed the schedules and then said deliveries were ahead of schedules.

I thought Oscar R. Ewing was spoofing when he gave $20,000 from the Nationl Institute of Health to find out about "tolerance and environmental stress in aged and newborn sheep" but, of course, Congress has passed that new income tax and it may just be a desperate method of getting rid of some of the old funds.

I'm sure the Corps of U. S. Engineers must have been spoofing when it estimated the cost of housing for construction workers at $300,000 and it ended up at $11½ millions.

Today we are not only being spoofed to the tune of billions of dollars but we are risking something more important —our way of life.

I'm going to keep away from the world scene where we've been spoofed by Soviet Russia until we are lucky to have our national shirt on our back, and limit myself to the domestic picture where a few politicians of both parties, a few bureaucrats, a few cosmic columnists, and a few labor potentates have spoofed private industry and business and the professions until we stand around with eyes popping and mouths agape like the proverbial sucker at his first carnival.

We appear to forget what has taken us this far and devote ourselves to speculating about the possibilities of government enterprise. We reaped the fruits of capitalism without recognizing what has produced the lavish harvest.

So far our private enterprise system has shown a tenacity all its own. It has survived with remarkably little help from us—its operators.

It is like the round safe that was in the Farmers and Merchants Bank at Crescent, Oklahoma. We had a bank robbery — one of those slick, professional jobs where the robbers come in force and carry off the safe to be opened at leisure.

The gang came in after mid-night in big black sedans with machine guns in the back seats and a truck to load the safe. They captured the night watchman and the night telephone operator. They cut the telephone wires out of town. The plate glass in the bank window was knocked out and a chain fastened around the pedestal of the round safe that stood by the window. The truck jerked the safe into the street but when the robbers tried to load it, it was so heavy it lifted the front wheels of the truck into the air like a bucking bronco. They couldn't pull it up a ramp because the round shape spread the ramp apart. After working about four hours until dawn, the robbers were forced to flee, leaving the stubborn round safe and a number of concave holes in the middle of Main Street as souvenirs of their colossal failure.

Our radical economic system has shown the same stubborn resistance to being robbed by the bands of Keynesian economists, national socialists, and communists. The danger is that we stand around laughing at the queer antics of the robbers trying to load the round safe while a group of confidence men are using our tax money to buy an easy-to-load rectangular safe.

The Oil Industry

In the government vs private enterprise dispute the pro-government faction has crossed up the private capital faction in the tidelands fight by calling it state vs federal control but it is a skirmish in the same old struggle.

The Interstate Oil Compact Commission sets the rules for state and individual leases and the oil operator gets the same deal on both. He goes ahead on his own initiative except for conservation regulations. But oil operators, especially small ones, avoid the entangling red tape of federal leases as much as they can.

How do I know? I didn't have to take a poll. In 1950 there were 43,000 wells drilled in the U. S. Of these only 2 per cent were drilled on the one-fourth of the United States owned by the federal government.

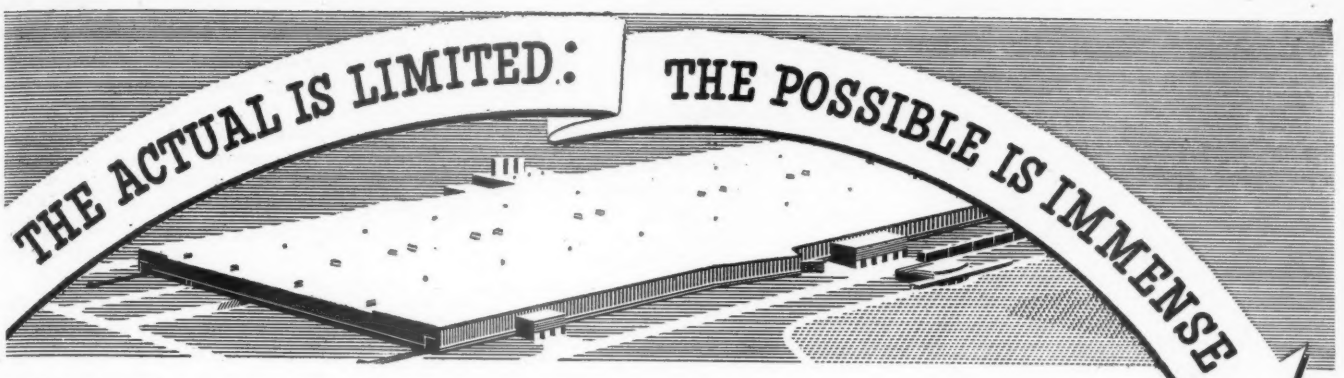
In the 30 years since federal oil and gas leases have been permitted the public domain has produced one billion barrels of oil. At this rate it would take 400 years to produce the 15 billion barrels estimated to be in the submerged lands of the Gulf.

What if the private oil industry wouldn't risk its money to find oil in the Gulf under federal leases? Operators have shown their dislike of federal control in the far vaster land areas of the public domain and in the Gulf they have to pay a million or more dollars for a rig and dodge typhoons while they are drilling. It may not seem worthwhile when a federal bureau in Washington can make you stop producing oil even if you are lucky enough to find it.

In that case some U. S. bureau would run the show itself. The Canol project was such an operation and in that we got

†Presented before the Petroleum Electric Power Association at its 23rd annual meeting, The Shamrock Hotel, Houston, Texas, November 19-20, 1951.

*Managing Editor.



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THE welding applications shown are typical of what is being done in principal refineries to increase the usefulness of existing equipment . . . to construct new or special equipment at low cost.

For high quality welds required for refinery work involving carbon, alloy or stainless steels, Lincoln's complete line of welding and hardsurfacing electrodes assure the right weld metal for every welding need. With Lincoln "Shield-Arc's" Dual Continuous Control, each operator has at his fingertips the right type of arc as well as correct arc intensity for faster, easier welding in flat, vertical, overhead positions to simplify and speed the job.

LATEST WELDING TECHNIQUES for all types of joints and metals are available in the new 9th Edition "Procedure Handbook of Arc Welding Design and Practice." Includes data on welding speeds and costs. Price only $2.00 postpaid in the U.S.A.; $2.50 elsewhere.

Restores Ring Grooves of flanges by adding weld beads of "Stainweld A5-Cb" electrode and finishing with pass of "Stainweld D" electrode for machineability.

New Lining for high pressure exchanger is fabricated from 8" wide strips of 16 gauge stainless steel, plug welded to the exchanger with "Stainweld" electrode and then weld assembled with continuous butt welds.

Adds Adapter Assembly to 30,000 gallon tank. Cut from ⅜" plate and 24" pipe, the adapter is clamped to tank and fillet welded with "Fleetweld 5".

for prolonging life of equipment

Reclaims Valve Body whose inside wall is corroded ½" by building up area with "Stainweld D" electrode (25% chromium—20% nickel).

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Adds Steam Jacket for valves used on asphalt lines. Splices piece of 3" pipe after coping out V's, bending and welding with "Fleetweld 5" electrode. Nipples are ¾" pipe fillet welded to jacket.

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a million barrels of oil for $150 million—in other words, our oil cost us $150 a barrel.

You hear a lot about $40 billion worth of oil in the submerged lands of the Gulf that should be used for federal education and the pious statement that this oil should be for all the people. Not a word about how much it will cost to recover the oil or how it can be done most efficiently.

But don't be spoofed. Federal control of oil development in the tidelands will cost you money and cost you in oil products, as Federal control of other oil projects have cost you money and oil reserves in the past and are costing you right now. It makes no difference whether you live in Maine or Louisiana.

The free enterprise oil industry is now producing taxes at the rate of $4 billion a year in addition to providing the people of the United States with all the oil products they want at the world's lowest prices.

What do you call that? I call it oil for all the people and a better bargain than they'll ever make with a federal bureau.

Electric Power Industry

This nation has one-fourteenth the world's population but it produces one-half the world's electrical power at what is said to be the lowest price of any commodity on the market. In mid-year, when the cost of living index stood at 185.5, the electricity index was 91.2.

This spectacular achievement doesn't make the headlines but you hear a lot about another TVA here, there, and everywhere—in the Missouri Valley, in Washington state, in Arizona.

The marvel and wonder of Tennessee Valley Administration is another bureaucratic spoof. If you tried the same bookkeeping system, you would get the book thrown at you.

TVA has charged off $150 million for flood control—10 times what it was estimated by the federal government. It has charged off $150 million to navigation, which is ridiculous. It would be cheaper to send all the freight carried on the Tennessee River by rail.

It pays no interest on the money supplied by taxpayers. It pays no taxes. It doesn't consider the loss of a $13 million yearly crop once reaped from the flooded lands.

C. J. Green, a professional engineering accountant, who was with the Federal Power Commission for 20 years, estimates that TVA power rates would have to be doubled to operate on the same basis as private utilities in the area.

In recent years there have been some hard fought battles to hold off federal water and power planning. There have been some interstate compacts to plan local flood control. The landowners in individual watersheds are beginning to sit up and take notice. The promoters of big dams are being faced with determined advocates of surface treatment of land and small detention dams. The radiation of local enterprise is far from dead. It is stronger than we think.

Mechanical Energy

Dr. R. J. Gonzales of Humble Oil and Refining Company says that the U. S. uses ten times as much mechanical energy per capita as the rest of the world. He says it would take 50 servants for every man, woman, and child in the nation to produce that much energy.

We have produced this fabulous wealth by the most revolutionary, the most exciting economic system of all time—akin to the discovery of fire in the history of man. Why do we still listen to those who dress up a system of communal property that was old when history began and has failed repeatedly?

When you hear those luring phrases "oil for all the people" or "power for all the people" know it for what it is—a spoof. Who has been getting the most and cheapest power? Who has been getting the best and cheapest oil products in history?

Not Socialist Britain, not semi-socialist France, not the big bogeyman, Communist Russia.

No, just us U. S. consumers, who expect everything we get and don't seem to realize what generates our huge production.

Who Gets Hurt?

The strange thing about the struggle of private capital as opposed to government capital—meaning forced tax capital—is that the ones who will suffer most under government control are least aware of their fate.

Suppose the government took over the electric industry tomorrow. The management of the industry would be the least hurt of any one.

In the first place you wouldn't have to work as hard as you do now. Some government bureaus require four persons to do the same work that one does in private industry, but you should get along all right with two on your job because you're experienced and you should be able to carry the brother-in-law of the local precinct captain without much trouble.

If you have just an average income, it may be raised because Washington, D. C., made up mostly of federal employees, has the highest average income in the nation and that was before the last overall raise, so you should fare well enough on salary.

You'd have more vacation time and more sick leave and perhaps more pension. You'd have twice as many employees under you because they would be doubled, too, and that should make you twice as important.

But you wouldn't have as much responsibility because the head man would be a political appointee and he would be changed often enough so he wouldn't get to check up on what you are doing or not doing.

The stockholders won't lose anything. The government can pay them off in 49-cent dollars or trade them government bonds on which they won't have to pay taxes.

Everybody is ahead. Everybody wins.

But wait. What about that guy, the consumer? Well, he loses but, bless his heart, he won't know it. It won't be on the electric bill. That will probably be lower. It will be on his taxes and they are so big now that nobody can itemize them. He doesn't even know how much they are, for sure, because the boss collects them for the federal government before he ever sees the money.

The trouble with that picture is that we're all consumers and if we pay for electricity in taxes when the government takes over we'll also be paying for petroleum products, for steel products, and for everything else we buy, as we are already paying for farm products, for RFC financing, for Mr. Ewing's Health Research, and for countless other projects that could be done more efficiently by local agencies or by individuals, or that we could get along without, as in the case of the research on the "tolerance and environmental stress on old and young sheep".

How It Has Worked

Now I'm not going to show you how federal control of business would work by telling you how the British endured cold and cut down on light because, even after three price increases, the socialized electrical program fell on its face and how they planned "load limiters" for every British home so that if a householder put on an extra kilowatt more than permitted all the electricity would automatically go off.

I'm going to tell you instead about the beneficence and efficiency of our own government. When we were paying out a few billions to help out our European friends (and some enemies) in 1949 some American Indians out on our Western Plains faced starvation. If you feel like letting the government take care of you—look how it took care of the Navajos.

The Navajos live mostly on their livestock and some crops and the starvation in 1949 was the result of a long series of control ideas by the Great White Father.

In 1933 the tribe was ordered to get rid of their goats. Indians who refused were arrested. They got 30 cents for some goats but that didn't bother Washington. One Indian who didn't have any goats was ordered to get rid of 27 so his neighbors gave him 27 goats to get rid of.

A 3 per cent Federal tax on electrical energy for domestic or commercial consumption was levied by the Revenue Act of 1932. In 1933, the first full year, it brought in $28,563,000. By 1950, collections had tripled and totaled $85,704,000—enough to pay a monthly $5 electric bill for 17,140,800 consumers.
—*Tax Outlook.*

In 1934 they were ordered to sell 80 per cent of the lamb crop; then in 1935 the Great White Father said each district must get rid of more sheep.

The remaining stock dwindled instead of increasing. Probably the owners decided it was against government regulations to build up a herd. Prices went up and it was too expensive to buy sheep and goats even if allowed to. So in 1949 the Indians were starving and freezing.

The Indian is a full American citizen except that he cannot buy liquor or control communal property. All income from communal property goes into the U. S. treasury and to get any for use the tribe must petition the U. S. government. If you have ever had any dealings with Washington bureaus you know how quick that petition can get buried and how long it will stay under mounds of red tape. When the Navajos were starving in 1949 the tribe had $2 million in communal funds buried in the U. S. Treasury.

The Indians can tell you plenty about bureaucratic care. According to their numbers they have twice as many federal employees controlling them as we have controlling us and they are faring twice as bad.

Why Be Spoofed

Why do we let ourselves fall for the worn-out idea that the government can do it better?

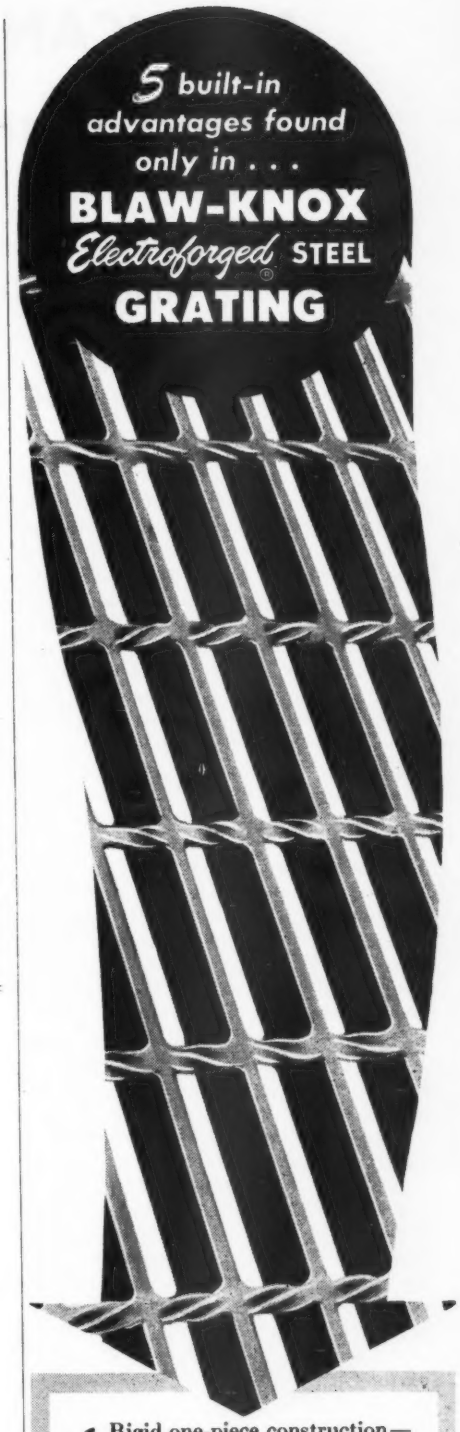
W. Alton Jones, president of Cities Service Company, made a speech down in Beaumont on "Communism Is As Communism Does," which was a penetrating analysis of the similarity between communism and the ideas promoted by some of our present leaders. I contend that it is also true that "Capitalism Is As Capitalism Does" and it is time for the beneficiaries of capitalism to stand up and be counted.

Private enterprise has begun in some measure to explain to the public the importance of its doctrine. But we need more of this knowledge—in our schools and at home, in the office and factory. The middle and lower income groups will be the ones who suffer most under government enterprise but who knows that? Management becomes federal bureaus and the rest of us will divide poverty as the British divide it, or divide slavery as the Russians divide it.

The strength that comes from millions of men and women working out their own economic problems, freely engaging in business and industry with the right to risk failure and the right to enjoy the profits of success is so powerful a system of economics that in five generations after the American colonies threw off the control of England, the U. S. is the leading nation in the world and so far in advance of the others that we can help the world.

The power of free enterprise is so tremendous that timid peoples fear it and outlaw nations want to scrap it.

We have developed the atomic energy of economics. It is no secret and it is time we use it on the offensive.* * *



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AMERICAN REFINERIES —some first impressions†

An Englishman relates some of opinions he formed during a visit to the United States

H. KAYE*

FIVE weeks spent in as many different states of the Union is hardly sufficient experience of America to speak authoritatively on that country — but it has enabled me to form first impressions.

My visits ranged from the larger 75,000 bbl per day refineries to the smaller plants with a throughput of around 5000 bbl per day, and so I saw a fair cross section of the American petroleum refining industry, employing most of the processes in use today. Perhaps the most significant factor in these processes is their high 'on stream' figures, which are generally of the order of 95 per cent utilization, and in some cases even 97 per cent. Twelve days shut-down is considered time in which to completely overhaul a plant and render it capable of another 50 weeks continuous operation. For the more difficult units, an intermediate four- or five-day shut-down for cleaning out is permitted after 6 months. Unplanned shut-downs caused by the failure of an individual piece of equipment do sometimes occur, but they are of short duration and infrequent.

The credit for such high standards is partly due to the American process designer, whose processes are capable of being operated without too much difficulty, and partly due to the equipment manufacturers who are eager to supply the right component for the job. In this connection, the American manufacturer is aided by a wide choice of construction materials, but his design is the result of long and close association with the petroleum refining industry. New processes must conform to a 95 per cent minimum utilization factor if they are to be of interest to the American refiner.

It is this reputation for reliability which has made the American designed process or the American manufactured component so attractive to the British petroleum refining industry.

It was interesting to learn that a plant can be completely overhauled in 12 days, at the end of which time every single item of equipment in the plant will have been inspected and, where necessary, repaired. The technique employed is worth noting. In the first place, the plant is completely inspected, usually by trained inspectors, who employ various instruments, such as the Penetron and Audigauge, to determine vessel and pipe line thicknesses. The readings obtained by these inspectors enable them to predict which items will require replacement at the next shut-down 12 months hence. They also serve to confirm their predictions made 12 months earlier, on the basis of which replacement pipe lines and replacement vessels will be to hand for the current shut-down. The amount of unexpected repair work on pipe lines and vessels is therefore reduced to a minimum, and prefabrication reduces overhaul to a simple replacement of faulty sections. Since process pumps are invariably mounted in duplicate, pump overhaul is not a factor in an annual shut-down.

Heat exchanger cleaning — always a time-consuming job — is eliminated by substituting spare bundles for the dirty ones which are then left to be cleaned at a more convenient time. Careful planning insures that no hold-up occurs through lack of men or materials.

The labor employed on continuously operating process plant does not normally affect the efficiency of the plant except in terms of the number of men employed. Process workers may be regarded as watchmen rather than as productive workers and, as such, contribute little to the output of a well-designed and instrumented plant. This fact is as true in Britain as in America but, because of the high wages paid in America, designers are always on the alert to reduce the number of men required per shift, without necessarily increasing the manual work of those remaining. To this end, the tendency is to group two or three continuously operating plants around a single control room or panel, and then to have one shift foreman in charge of all these plants. The centralized controls insure that the foreman can check the operation of all plants without having to travel any distance to do it. Generally speaking, the saving in manpower achieved by this arrangement amounts to one man per shift when two units are combined, and two men per shift if three units are combined.

The instrumentation of the majority of American plants is not significantly different to that of their counterparts in Britain. As noted above, however, the centralization of all instruments on a single panel is more common in America, where even the old plants have regrouped their instruments in this fashion. The graphic panel is not universally acceptable since it does not lend itself to the modifications which inevitably occur in a new process. On the other hand, the graphic panel does have a sales value and serves to impress the visitor.

In those sections of the refinery where the employee is called upon to perform manual work, powered tools are employed to reduce the physical strain and to speed up the job. A pipe fitter carries the majority of his spanners (made from lightweight alloy) in a case or pouch strapped around his middle, and whether he is on the ground or in the air his spanners are within reach.

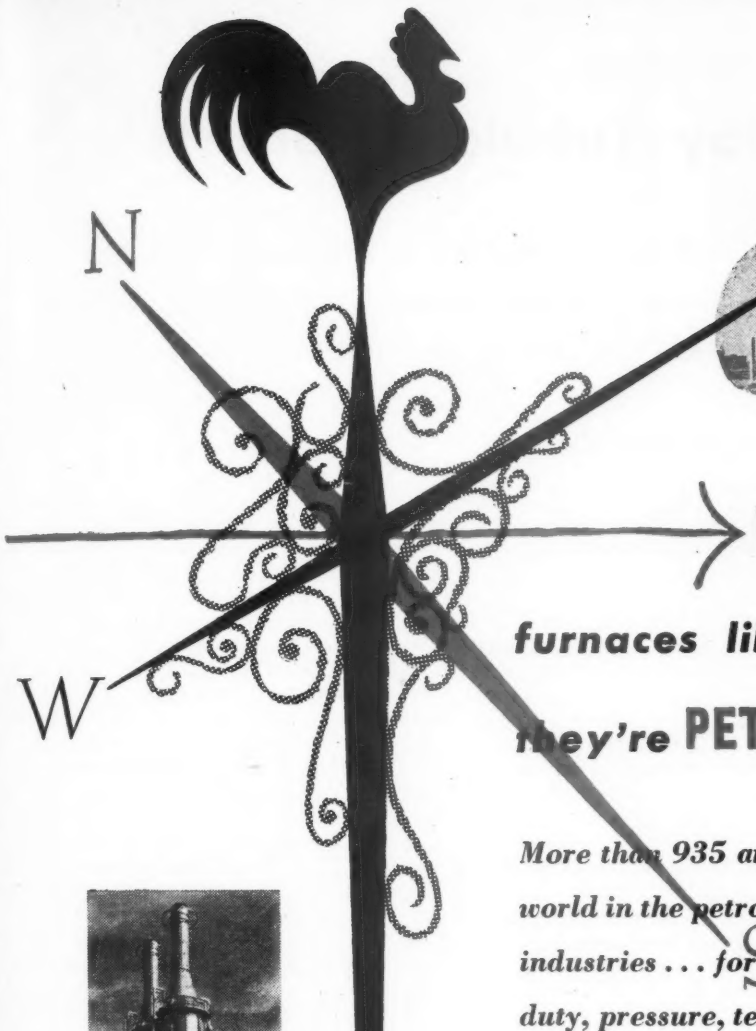
The American is a hard worker, and even when the job carries no piece rate or incentive bonus, his effort and output are high. This is partly attributable to the fact that although the American employee receives a high wage by our standards, he is a prolific spender—and in a country where consumer goods are readily available he has an ever-pressing need for more money. This need he satisfies by seeking promotion to a more highly paid job and, in most refineries, the promotion ladder is carefully defined, so that each employee knows the next step before him. Competition for promotion from step to step is keen, and each step will mean an increase of from 50 to 10 cents per hour.

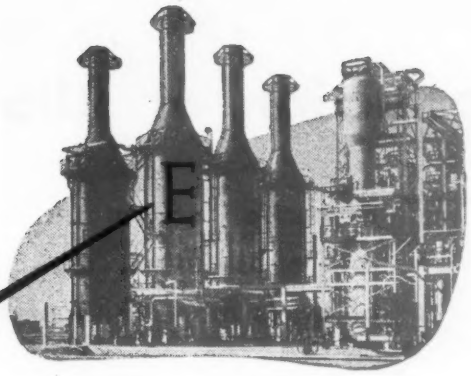
American refineries are highly 'safety conscious' and many vehicles other than the poster are used for carrying the safety message. In one refinery, the employees are grouped into zones each containing approximately 100 men. When a zone completes 250,000 man hours worked without lost time accident, the members of this zone are entertained to dinner by the directors of the company; after 500,000 man hours, the members and their wives are entertained to dinner; and after 750,000 man hours a more elaborate dinner is provided. When the total man hours worked without lost time accident reaches a million, the celebrations include a dinner for members and wives and a cash bonus for members. In addition, the members of the zone are admitted to the "Million-man-hour Club," their plants or workshops are decorated with bunting, and a framed "Presidential Citation" finds an honored place on the control panel or workshop wall. Joint management/employee safety committees are active in all refineries and competition between refineries is encouraged by nation-wide safety competitions.

I have tried to give a few of the impressions gained during my visit to the United States. But I have not yet mentioned the strongest impression of all—the kindness and generosity of the American petroleum industry. American oil-men spared neither time nor trouble in welcoming their English visitor and in giving him some of the benefits of their experience and knowledge. * *

†Reprinted by courtesy of Oil, the Journal of Manchester Oil Refinery Group of Companies, England.

*Process Superintendent, Manchester Oil Refinery, Ltd.





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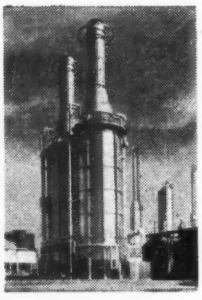

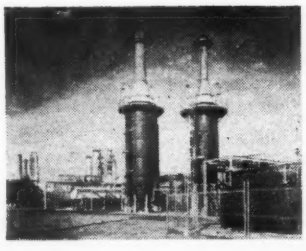

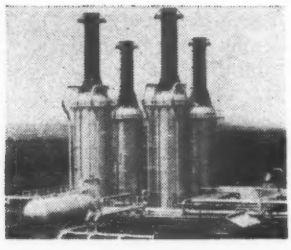

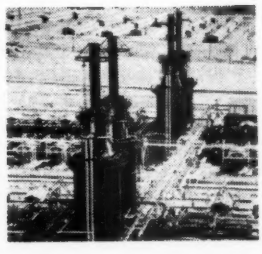

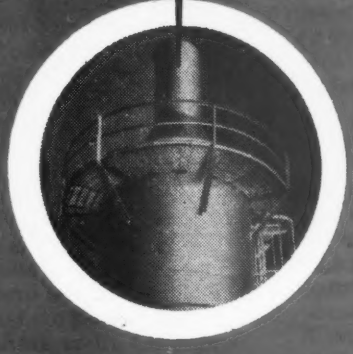

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Production of Alloy Tubular Products†

Reduction of amounts of scarce metals in alloys and substitutions may reach a stage where failure of parts more than offsets the saving of material

JOHN J. B. RUTHERFORD*

THE oil industry has come a long way since a piece of indiscriminate lapweld pipe would serve for casing or line pipe to bring crude oil over to a riveted shell still for refining. Readily available, shallow pools have been exploited and exhausted so that now it is necessary to develop deeper higher-pressure wells. When once procured, the crude is processed at much higher temperatures and pressures than formerly to obtain the proper physiochemical reactions and also to permit the economics of larger throughput.

In the production of oil, tubular parts require to be high in strength at ordinary temperatures, say minus 50 to plus 300 F. This high strength to resist failure from internal or external pressure, or to resist the pull of a 20,000-ft string, must be accompanied by good ductility to withstand abuse in the field. Attention has been focused recently on the notch sensitivity of steels when treated to obtain high tensile strength. As the yield strength approaches the tensile strength, at higher values, there is less "give" to the material before it fails from what appears to be a sudden rupture. The metal to meet these requirements must lend itself to simple manufacturing processes in order to be made in large quantities, and must also be suitable for welding or machining to precision threads. Corrosion problems are encountered that may be associated with the behavior of the metal surface, its texture, characteristics of the scale layer, and also the uniformity of metal structure. Condensate-well tubing presents a peculiar and expensive set of problems, as may be judged by activities of various corrosion committees.

Refinery Aspects

The refining end of the business bears practically no relation to the production end, except maybe in the common feature that a tube is the most convenient device for handling fluids. This requires steels to resist creep and rupture at elevated temperatures, and also to resist corrosion from sulfur compounds or brine, oxidation, and carburization. The engineering properties of a metal at elevated temperatures cannot be judged by any tests at ordinary temperatures. To obtain such information, it is necessary to perform creep and stress rupture tests that require months for each individual test. It frequently comes as a surprise to realize that all the creep data accumulated over 25 years—relating to the 10 steels most commonly used in refinery service—can be conveniently summarized in a few pages of charts. Anyone faced with the problem of changing these alloys, other than minor modifications, is confronted with a major time-consuming project, with rather discouraging prospects. Some refining operations, like dewaxing, involve subnormal temperatures. Again, the properties of steel at minus 100 F cannot be anticipated from tests performed at plus 70 F.

Critical

The situation confronting the oil industry today is one of shortages or scarcities. Even the basic commodity—steel—is temporarily in short supply. Many of the alloying elements are critically short, such as columbium, nickel, molybdenum, etc., and some may never again assume the ready availability that was apparent in the past. It is obvious that a simple steel cannot perform suitably all the requirements that have been outlined. Additions have been made, in varying amounts for different service conditions, of aluminum, chromium, columbium, copper, manganese, molybdenum, nickel, silicon, titanium and tungsten, and vanadium. Some of these elements are quite restrictive in the benefits they contribute, whereas some are very specific in their effects, such as chromium aiding corrosion resistance and molybdenum aiding high-temperature strength.

Considerable publicity has been afforded the use of boron as an additive to steel. With medium-carbon steels containing minor alloying additions, such as manganese, a very small addition of boron is effective in raising the strength properties at ordinary temperatures. This may offer some aid when tensile strength is the primary requirement. A considerable amount of test data have been accumulated on the substitution of chromium or manganese, possibly with vanadium, for molybdenum in casing, tubing, and drill pipe. These tests have been very satisfactory from the standpoint of strength requirements, product quality, and threading, but still require service tests. It is the opinion of the pipe manufacturers that molybdenum should be retained for grade "E" drill pipe because of the critical requirements in deep drilling. The high-temperature steels contain mainly chromium and molybdenum, of which the latter is most critical. The molybdenum content of these alloys is being reduced by an amount which is considered safe and expedient without changing the basic characteristics. A recommendation has been submitted to reduce the number of high-temperature ferritic alloys in half and thereby effect a saving through standardization and reduction of interchangeable spares. It is further recommended that molybdenum-containing refinery tubing should be restricted to service at temperatures above 775 F. Suggestions are being considered for policing new construction to insure against profligate use of these alloys. For low-temperature applications, where nickel steels have given excellent service by retaining high toughness, it may be necessary to use aluminum-killed steel and to design so as to minimize stress-raising sections.

How Much Further?

You may question how much further it is possible to carry the program of reducing alloys. The high-strength drill pipe, condensate-well tubing, and some of the high-temperature tubing applications are already at the stage where production is being lost from rapid failure of parts. The first step, then, is a statistical study of the service life. In some cases no reduction in alloy content seems feasible; in others, strength may be obtained from heat treatment or cold working as a substitute for alloy—provided facilities are available. In still other cases alloys to aid corrosion may be replaced by the use of chemical inhibitors, thus substituting man-hours of maintenance for the strategic alloy. It is difficult to project too far into the future because the alloys available today may be the more critical ones tomorrow.

* * *

†Presented at a symposium on the outlook on steel for the oil industry, during the 31st annual meeting of the American Petroleum Institute, Chicago, Illinois, November 6, 1951.

*The Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania.

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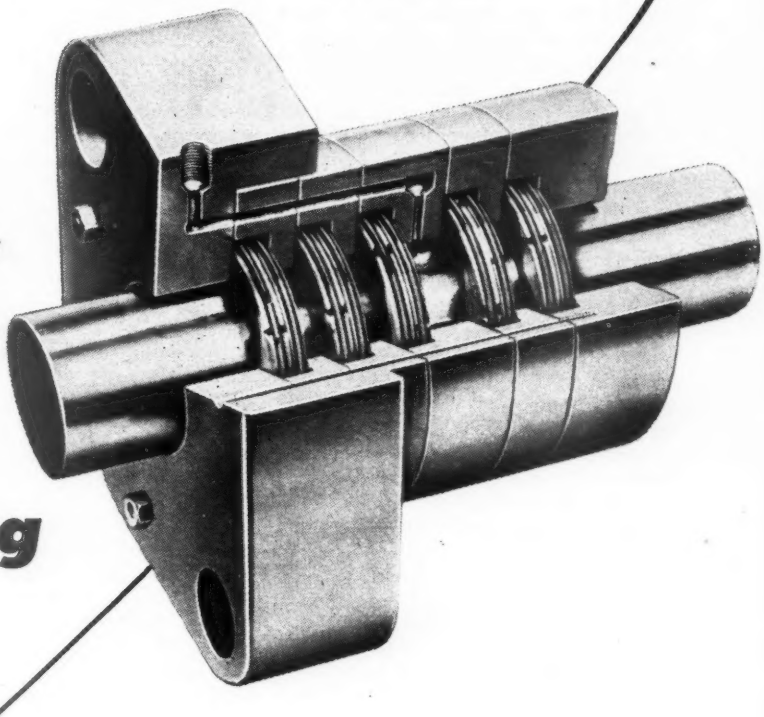

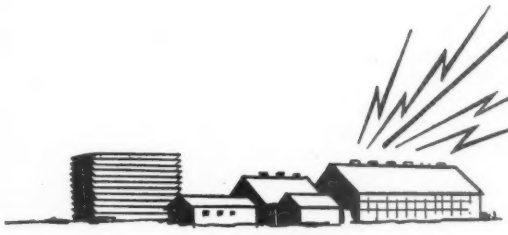

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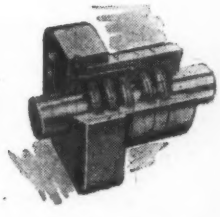


. . . SEALING PRESSURES SINCE 1888 . . .

THE THREE MUSKETEERS

Progress of U. S. Petroleum Industry is firmly backed up by the vital

THE Drake well discovered oil in 1859. This marked the humble beginning of the oil industry of the United States as we know it today. In the short space of 94 years the oil industry has had an astonishing record of growth. Today it occupies an important place among the leading basic industries of the world, engaged as it is in the winning of a raw natural resource and the manufacture of products therefrom. What are the elements entering into its record of progress and growth that have brought it to its present high state of development?

For an answer, at least in part, we must turn to the manufacturer of oil field equipment and his constant research in design, to the companies engaged in supply and distribution, and to the service companies rendering special vital services demanded by the peculiar needs of the oil and gas industry.

Ever since it became an industry, oil has leaned heavily on the steel industry for the metal from which to fashion its tools, and also for the manufacture of its tubular goods, of which it is a large consumer. Totally unlike other basic industries, however, it had to start from scratch to develop its own tools and miscellaneous other supplies and equipment. The operations involved in oil and gas development are highly specialized.

Oil and gas development involves the use of specialized equipment and it is in this connection that manufacturers, suppliers, and service companies entered the picture and became an important part of the oil and gas industry. The functions and contributions of each of these three groups and how it operates form an interesting backdrop of solid achievement. Major companies and independent operators alike have profited from the notable services they have rendered and continue to render. Their business is for the most part highly competitive. Their operations are extensive and there are many companies in each group.

Manufacturers have many available sources for widespread distribution of their products. In addition, they have their own representatives in the field available for service and competent engineering advice.

Warehousing and distribution are important functions of suppliers. Supply warehouses are found in every active field; even after development is completed, they are a necessary link between the manufacturer and the oil producer.

Service companies are specialists, perform vital services that are far-reaching in economic importance. Like other field services, they are on call 24 hours a day.

The part played by manufacturers, suppliers, and service companies in oil and gas field development, in the introduction of new methods and equipment, and in technical advances, is much greater than is generally realized. It is due largely to the efforts of this group and their cooperation with the oil companies that the American oil and gas industry has been a leader in developing equipment and materials for oil and gas development throughout the world. Included among the manufacturers are companies engaged in the design and manufacture of special equipment. Equipment of this type is, in most cases, peculiar to the oil industry. By concentrating on this particular equipment, including the close observation of its performance in the field, these manufacturers have become specialists in their own right. They are thoroughly conversant with the proper application of their product. They are constantly striving for ways to improve its design with a view to its more efficient operation, and to extend its service life. They are in constant touch and work closely with oil company personnel in the field. Many of them maintain their own research department.

Some manufacturers are also engaged in the supply and distribution end of the business. The part they play in supplying equipment when and where needed fills an important economic function in the development of oil and gas fields. Indeed, the burden of distributing this equipment and having it available where needed falls on the supplier. No matter how remote a wildcat well, or how inaccessible the area, supplies are usually available when required. As soon as a new field is discovered the first people to move in are the supply companies. They establish field warehouses at convenient points. These are manned by experienced personnel and are an important link between the operating branches of the industry and the manufacturer in supplying the needs of the oil operators.

In earlier days during the active development of a field some larger oil companies carried a large inventory of materials and supplies and had their own warehouses. Today the burden of this supply problem is left to the companies engaged in supply and distribution. By following this practice great savings to the oil companies have resulted.

CONSIDERED alongside the drilling and producing equipment in use today, the tools in the early days of the industry were incredibly crude. When the Drake well was drilled the search for oil by drilling was something new. Its nearest counterpart was that of drilling for salt water, a type of operation that it soon surpassed. By necessity, the industry in the beginning had to design and develop its own tools. Crude makeshift rigs fashioned from the materials available were looked upon as nothing unusual in those days. How to apply the power to the drill, the type of bit, how to remove the cuttings, were fundamental problems that had to be solved. Their solution was usually left to the ingenuity of the driller, who was sometimes his own tool designer and manufacturer.

It was natural, therefore, that the manufacturer of oil equipment gradually came to assume an important place in oil field development. Indeed, progress in the oil industry, particularly in the drilling and producing branches, has depended largely on the manufacturer. He, more than anyone else, looked ahead and anticipated the design of equipment to overcome problems as they arose. In this regard, he has been confronted at times with formidable problems that seemed impossible of solution. This explains the fact that increasing depths to which wells are drilled parallels the development of equipment to do the job. Today, thanks to the sagacity of the manufacturer, equipment is available to go to depths thousands of feet greater than present needs.

The three broad divisions of this

OF THE OIL INDUSTRY

support of equipment manufacturers, suppliers, and service companies

group include research in design of equipment, conducted by the manufacturer, the problems of supply and distribution, and the development and application of special equipment and services. To this group more than any other goes the credit for a large measure of the success the drilling and producing branches have attained in overcoming many field problems.

Their relations with the oil companies are important. They are engaged in nearly every phase of the many ramifications of oil development operations. Major companies and independent operators alike profit from the services they render. Their business, as might be expected, is highly competitive. Their operations cover widely separated areas, and their services are available wherever oil is found.

THE manufacturer's valuable contributions to the industry are usually taken for granted. He has constantly anticipated industry's needs; has developed equipment to drill to great depths—even greater than the record depths now reached. Likewise, he is constantly improving and developing equipment for producing oil from still much greater depths — depths not thought possible a few short years ago. Through research and advanced methods of design, manufacturers have been directly responsible for the vast strides made in automatic drilling, increased rate of penetration, safety in drilling and completing wells (despite greater drilling depths and inordinately high pressures, blow-outs today are rare).

To the manufacturer, and particularly the enterprising specialty manufacturer, the industry is indebted for much of its progress. He employs technical and engineering talent, cooperates with the oil operator in field research and in the solution of difficult operating problems. The manufacturer has been directly responsible, probably more than any other individual, for introducing new advanced practices in drilling and producing operations. He maintains service men and, in many instances, service shops at convenient points in the field for the repair and proper maintenance of equipment. Manufacturer's representatives are constantly checking on the results being obtained from their respective pieces of equipment while in operation. Behind all this, unseen and unsung, are the research and experimentation preceding design—a substantial item of cost behind each successful product in use.

The time element and facilities involved are imponderables that the manufacturer must cope with. The demands made on the manufacturer of oil field equipment are many. Were these demands better known the efforts of the manufacturer would be better appreciated.

The specialty manufacturer is a persistent breed. He concentrates on his own products, constantly striving to improve them. He draws on the experience and results obtained in the field with his product and thus acquires a wealth of data in his line of equipment. This information is made available to the operator so that better service out of his equipment is made possible.

Those of the larger supply companies that are in the manufacturing end of the business engage in research, design, and engineering on a scale not generally recognized. They are constantly in touch with the latest developments and trends. They maintain service shops for the proper repair and maintenance of equipment. With their warehousing and distribution facilities the supply company-manufacturer and its personnel perform an indispensable service.

THE supply company is as old as the industry itself. It has grown up with the industry. Field supply stores and warehouses are an essential part of the oil field scene. They perform an important function in field operations. They provide supplies near the point of use. They remove the burden of large inventories from the oil operator. The number of items carried in a field supply store covers a wide range. The typical field supply man is a trained observer of the progress of field operations. He is a storehouse of information on local field conditions, supplies, and equipment. He has great versatility in handling oil field details and so is generally helpful to operators when called on for advice or information.

The economic problems of the supplier are many. Factors that enter include the number of supply stores and service shops, the dollar value of inventories carried, the warehouse, distribution, and general operating costs, the turnover of field supply stores, and claims and adjustments.

Profits before and after taxes on a percentage basis, taken from actual records, disclose the competitive nature of the supply business. The picture disclosed is by no means the bright one that might be expected. Supply companies now carry the bulk of equipment and material inventories rather than the oil operator. The evolution of supply companies and how their warehouse and distribution facilities function today, is a story of the oil industry in itself.

SERVICE companies are, in the main, specialists. They fill a highly important need in modern oilfield operations. Many of them design and manufacture their own equipment. Some even manufacture their own materials. Concentration on specific problems and experience in dealing with them make service companies experts in their field of service.

The main categories of service companies include such items as: Well cementing, chemical treatment of wells, well surveying, coring and core analysis, testing of tubular goods in the field, special cementing tools and equipment, pressure control and control equipment in wells, and perforating well casing.

Important operations in the field now carried out by rule of thumb are few and far between. Scientific procedure is the order of the day. Service companies today provide scientific equipment and specialists to operate it. As a group, they have done much to remove the hazards, physical and financial, from field exploration and development.

Although a relatively small group, service companies, because of the technical nature of the service they perform in the field, have an important place in field operations. Behind the field staff of some service companies there is a large research staff. The field personnel of many of these companies is available for making tests on the ground, for "time is of the essence" in their duties and results must be learned without delay.

PETROLEUM PROFILE

"A RESEARCH and development organization must be a bunch of magicians, to overcome such a serious handicap as (is) imposed by our tax laws". So spoke C. G. Kirkbride, research trailblazer, vice president of research and development activities for Houdry Process Corporation. His company is one of the outstanding process development outfits in the world, Kirkbride one of the chemical engineering industry's favorite sons.

The specific occasion was the speech presented by Kirkbride before the American Institute of Chemical Engineers early in December, where he was winner of the Celanese Corporation's Professional Progress Award, presented by the Institute for noteworthy contributions to the science and engineering developments of the industry. Looking at the present situation in America and the world, Kirkbride sees a strong and painful analogy between the conditions, political and industrywise, in this country at present and in the immediate past, and the conditions existing in England since 1870. And the comparisons and reasoning given by the speaker are not the vapid utterances of a ward politician; Kirkbride has been in the forefront of scientific and engineering development for more than 20 years, and has risen to a position where executive knowledge and ability are even more important than engineering know-how.

Following his line of thought closely, the basic reason for Britain's failure is an unsound attitude or philosophy caused by a lack of competition and individual incentives. The 'disease' that has brought her low gave evidences of its existence during her heyday, 1860-1870. The symptoms became more acute up to 1900. "Those symptoms today are open sores and can be cured only by a radical change in attitude". And, realizing that palliatives are seldom if ever cures, the speaker observed that pouring billions of American taxpayer's dollars into Britain is not the cure.

Today, in this country we have many of the symptoms that were so plainly apparent in Britain in 1900, with the progress of the "disease" much more rapid here than in that older country. A highly advanced case of technological stagnation exists in Britain now. We have many of those influences and attitudes in this country that directed her activities and government between 1870 and 1914, it was indicated, and this leader presented them as indictments of the trends in our civilization, of the ways of thought of a large proportion of our people. They are: Over-confidence: something-for-nothing; success-their-due; habit-of-extending-leisure-time: complacency-toward-cold-facts; a-mania-for-security.

A sound economic policy has the objective of maximum productivity of useful goods and services. To reach that status we protect individual incentive; vigorous competition is the stimulus to incentive; overburdensome tax laws eliminate the incentive in our system, and a "complete overhauling" of the body industrial and political is needed. The basic attitudes and philosophies required for a healthy incentive system can be destroyed in a generation. Kirkbride recommended the elimination of innumerable "hidden" taxes and the institution of a Federal sales tax that will show the people the taxes they actually are paying, then they will pressure lawmakers to stop waste in government.

C. G. KIRKBRIDE
Vice President Research and Development
Houdry Process Corporation

C. G. Kirkbride did not arrive at his present position of world-viewing technological progress and national economic health in one leap. He began where so much individual incentive has begun. Many barrels of oil have flowed from Oklahoma to the world; many oilmen have developed from that same land. Eventually with Bachelor's and Master's degrees in engineering from Michigan University, he began as chemical engineer with Standard of Indiana, where so many well-trained technical men have worked and wrought. After four years he was selected as assistant chief chemist of Pan American Refining Corporation, 1934, to be boosted to assistant director of research in 1938. The horizon was widening, and he went to Magnolia Petroleum Company's research laboratory at Dallas as chief of chemical engineering development, 1942.

Many prominent technical and scientific leaders have spent training periods in professorial capacities, gaining experience with human laws, in living with and directing people as well as natural laws and atoms. He spent 1944-47 as distinguished professor of chemical engineering, at Texas A&M College; was made director of research and development for Houdry Process Corporation in '47, and later was raised to a vice presidency in 1948.

A Test Procedure for COMPLETION FLUIDS

VERNON B. ZACHER

Abstract

Several emulsion muds used in the California oil fields are segregated into classes to determine the main characteristics to be expected of these types of emulsifiers when subjected to a simplified completion test. These characteristics are discussed in detail but with emphasis on the filtering or "sealing" process in the hole. A phase, not covered heretofore, of bottom-hole action of emulsion muds is analyzed. Attempt is made to bridge the gap between the classic theory of filtration and the actual result in the hole. That there are many hole conditions that seemingly contradict theory is true. Better understanding of the action of mud does not disprove but, rather, strengthens fundamental theory.

THIS paper will deal with two things:

1. Discussion of several emulsion muds in common use.
2. A proposed procedure of evaluating a completion fluid.

The above two parts are actually connected and integrated in two ways:

1. The identical emulsion muds are utilized in both parts to note their comparative performances.
2. By subjecting these muds to both the standard API fluid-loss test and the proposed completion fluid test, we are able to reconcile both procedures. The results justify the ordinary fluid loss test for drilling ordinary and reasonably impermeable formations. They also show necessity for the modified test in producing horizons.

The difficulty here is to be just detailed enough in the presentation of facts. Too much detailed data tend to becloud the report. In view of this we are excluding all but the necessary tabulations and curves. No attempt is made to cover all the muds in use, but only widely used typical ones.

In presenting a proposed completion fluid test it is realized that there are limitations. These items are anticipated and will be brought out. The interesting thing is that not one of the rather adequate mud tests in use in the field gives any tangible data on a correct completion fluid. It is realized that the development of such tests is timely and necessary. To illustrate this lack of such a test one could resort to permeability, porosity, core type, water type, and reservoir data without actually knowing the right fluid to use. A few laboratories doing both core and mud work could doubtlessly come up with an answer. They could do this but the results would usually be in too late to be of value in the well tested. The test herein described is fast enough to permit control of the completion fluid while the well is being drilled. Please note figures on hours saved, later described.

Discussion of Emulsion Muds

A. Emulsion Mud History. The date an emulsion mud was first used is credited to some driller in the South. The date is obscure as the emulsion muds probably were used first without awareness of it. This happened when oil was used to loosen stuck drill pipe.

B. Soap, Lignin, and Humic Derivative Emulsion Muds. At the outset, it is not intended that the following discussion of muds encourage selection or choice therefrom. It would be inadequate for this purpose, anyway, as the discussion is only limited to several well known types of mud.

Note: The following tabulation and curves on emulsion muds show results on typical field mixes. Materials used were basically an 80 lb P-95 mud, with 20 per cent 30 gravity Ventura crude.

Soap emulsions have some interesting inherent properties. The soap molecule is, by nature, a lubricant. In drilling operations, of drag and rotation of drill pipe, lubrication has been noted very definitely.

The soap, in an aqueous solution, tends to form a gel of its own because the soap molecule orients itself to arrange the water hating non-molar tails to escape the water. This forms a series of clusters known as micelles which, acting like large molecules, form the gel.

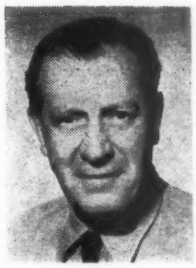
Regarding the curves, Figs. 1 and 2: It is shown that, due to increasing steepness on the "low dose" side, small amounts of emulsifier have little effect on fluid loss. On the other end (the high dose) we see the law of "diminishing returns" as the fluid loss is reduced only by adding unreasonable amounts of emulsifier. Curve 3 shows cake growth with time on these muds. Growth stops on all except limed muds at one hour.

The outstanding thing to note is that both limed muds show a greater fluid loss than do the others. The lignin derivative type shows the greatest, the soap type the least. The humic derivative type is second best in the non-limed, first in the limed mud. Various tabulations have been reviewed recently, on muds of these types, with the filter cake thickness being omitted. This is probably due to the fact that, in most muds, cakes are usually proportional to the fluid loss character. In these and other emulsion muds we note inconsistencies in this idea. Often cakes of greater thickness show a low fluid loss. The stability of the emulsion, as to its dispersed phase within the continuous, probably accounts for the apparent inconsistency. If the emulsion is not tight, or is easily broken, the released oil may tend to come out in the filter paper. These filter paper results are usually reproducible and have very good use in drilling mud control. The cake curves show an interesting tendency of the limed muds to give one slope (or steepness) and the unlimed, another. This slope difference averages about 3¾. The cake growth of limed muds could be assumed to have this character of thicker cake in dosages of less than 8 lb per barrel. At dosages of greater than 8 lb per barrel the limed humic type mud shows thinner cakes.

Later we shall note that, while these

EXCLUSIVE

The Author



V. B. Zacher received his education at Montana State College, receiving a Bachelor of Science degree in 1923, and a Mechanical Engineering degree in 1928.

Previously he served with the United States Army. He entered the service as a private and at his time of discharge was separated as a First Lieutenant in the Infantry. During his time of enlistment he received the Distinguished Service Cross, the Purple Heart, the French Legion of Honor, and the Croix de Guerre with Palm. He began his career in the Army in the Mexican Border Campaign and served in World War I in England and France. While in France he was wounded in the Muese-Argonne battle.

After his service with the Army he worked for two years for Standard Oil Company in the engineering department, 1923-1925. He is now completing his 25th year with Tidewater Associated Oil Company, presently as superintendent of technical and research department of western division.

During his career in the petroleum industry he has invented the Zacher filter press and other aids for facilitating oil field mud engineering.

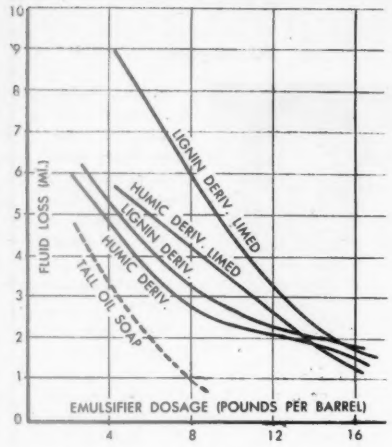


FIG. 1. Fluid loss vs emulsifier dosage.
80 lb. per cubic foot P-95 mud.
20 per cent 30 API Ventura crude oil.

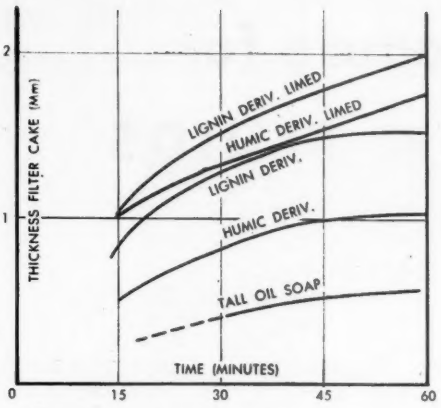


FIG. 3. Cake growth vs time
80 lb per cubic foot mud.
25 per cent 30 API Ventura crude oil.
10 lb per barrel of emulsifier.

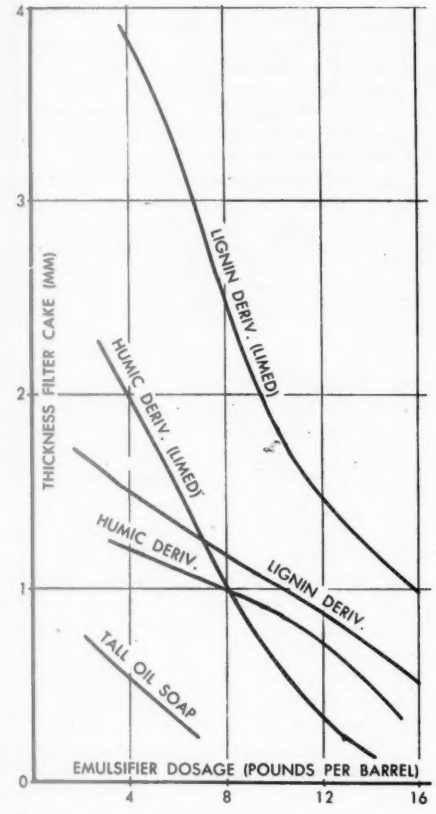


FIG. 2. Filter cake thickness vs emulsifier dosage.
80 lb per cubic foot P-95 mud.
20 per cent API Ventura crude oil.

tests are satisfactory on drilling fluid work, they are not so adequate when attempting to evaluate a mud for completion use.

A Proposed Method of Evaluating a Completion Fluid

A. General Discussion on Need of Liaison. It would be an unfortunate oversight to fail to point out at the start that a certain recent event proved a very pertinent point. This point is also very well brought out by Johnson and van Wingen[1] that there is a "lack of liaison between operating, engineering, and laboratory departments". The recent event in question is a meeting of the API Drilling and Production Practice Committees in Los Angeles. The scope of this meeting was late information on completion of oil wells. The meeting was built around a panel of people whose talents embodied core work, reservoir mechanics, petroleum engineering, geology, physics, chemistry, and mud engineering. This meeting was well attended and a successful one. The point here is that, if a group from various companies can pool their abilities, a similar one can surely be manifested within an oil company. Companies should start this so that the best efforts are pooled to get the oil out of the ground.

To consider the process necessary to apply the method described below, we should note Dr. Beeson's[2] several suggested steps necessary in a well completion. These steps, included in the "good core program" are:

1. Mineral knowledge (including hydratable material).
2. Study of pores and channels.
3. Note friable formations.
4. Permeability and porosity data.
5. Capillarity and electrical resistivity.
6. Damage by completion fluids.

We shall be concerned with No. 6 as our test should determine the fluid that will effect minimum damage to the producing sand adjacent to the hole. To conduct these tests a man should be familiar with core testing, sufficient reservoir mechanics, and lots of experience on drilling fluids. This man's familiarity with the crews and pushers will be most helpful. As said before, he must go beyond the usual boundaries required in straight mud engineering.

To be brief, let us assume now that the core lab man gives the mud engineer all data, samples of cores, etc., upon which to advise the correct completion fluid. At the present time the mud man can only advise approximately, except in very well known fields. The core lab, which also tests muds, may do the work but would usually be too late to be applied on the well.

B. The Method of Testing a Completion Fluid. The writing of this phase of this paper was done with a great awareness of the multitude of core and reservoir work done in the past. Perhaps the method described below would not absolutely be required in some fields where extensive data are known. There are few leases where a check test would not be time well spent. Sherborne and Pyle[3] describe an excellent process to evaluate cores in the field. The method herein described of evaluating completion fluids would not conflict with, but would enhance this core work.

The main characteristic of this completion fluid test is the speed with which results are obtained. An actual example will illustrate. In the following series of tabulations are included five different muds that were tested against three cores of different permeabilities. This makes 15 separate tests. Each of these tests required five operations as described in the next section under "C, Actual Steps".

Thus, to do these five operations on each of 15 tests yields a total of 75 operations, and required about 15 hours of work. To duplicate this work by ordinary methods would require an estimated two weeks of work. This time saving allows immediate tests for getting data to find the suitable completion fluid. The method is very simple but will probably undergo further refinement or simplification.

The instrument is a small core holder made to fit a 100 lb mud filter press. The filter press illustrated is the type described. The core holder, however, could be redesigned for other types of filter presses. This press is the type that delivers the filtrate from the horizontal position. The convenience of this type press is obvious, as the core holder was easily designed for simplicity and quick operation. The position of the core is also enhanced by the vertical positioning. An explanation of the core holder is as follows:

The metal housing for the conical rubber sleeve is substituted for the lid and screen with nothing else added. The rubber sleeve fits loosely into this metal housing for easy cleaning and allows minimum fluid clearance so that pressure is built up immediately. The seal with this housing is effected by a feather edge and the working pressure of the unit. Likewise, the $\frac{7}{8}$-in. core is a snug fit in the rubber sleeve, which also has a self-sealing lip preventing fluid by-pass by the working pressure. See detailed drawing, Fig. 5.

It must be borne in mind that this design, although allowing speedy results, must have limitations. We wish to anticipate all these limiting factors, if possible. Several come to mind immediately and, for clarity, should be listed as follows:

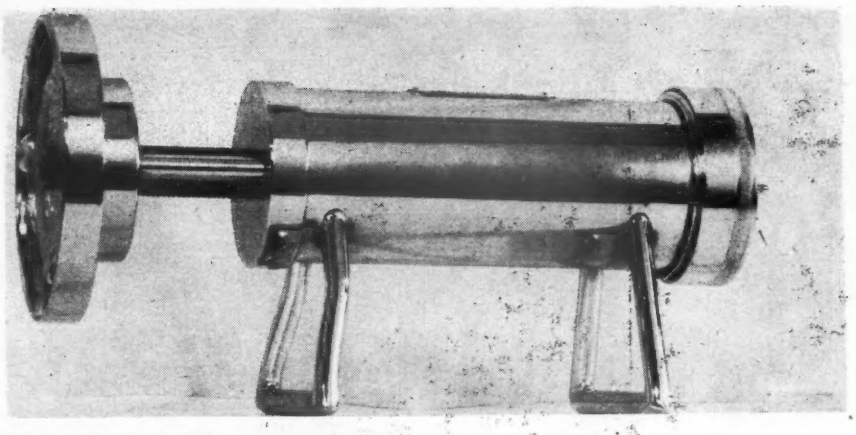


FIG. 4. Standard 100-lb mud filter press automatic core holder replaces lid and screen.

FIG. 5. Automatic seal core holder.

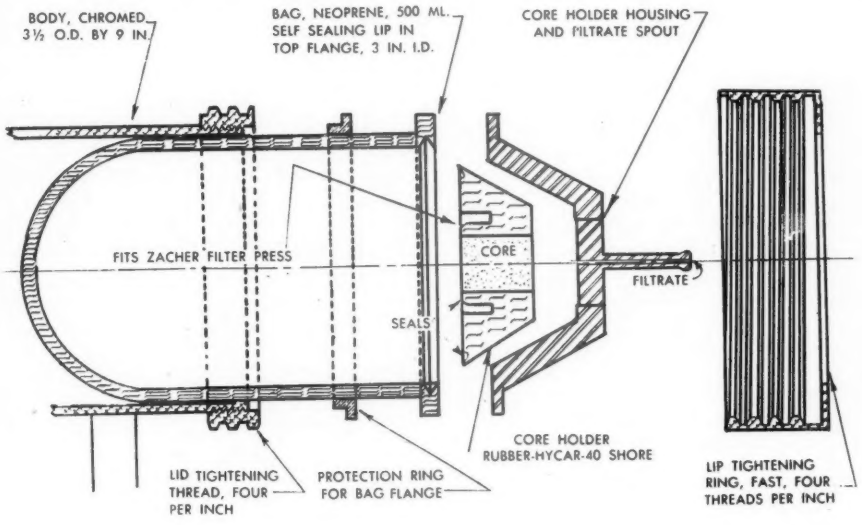
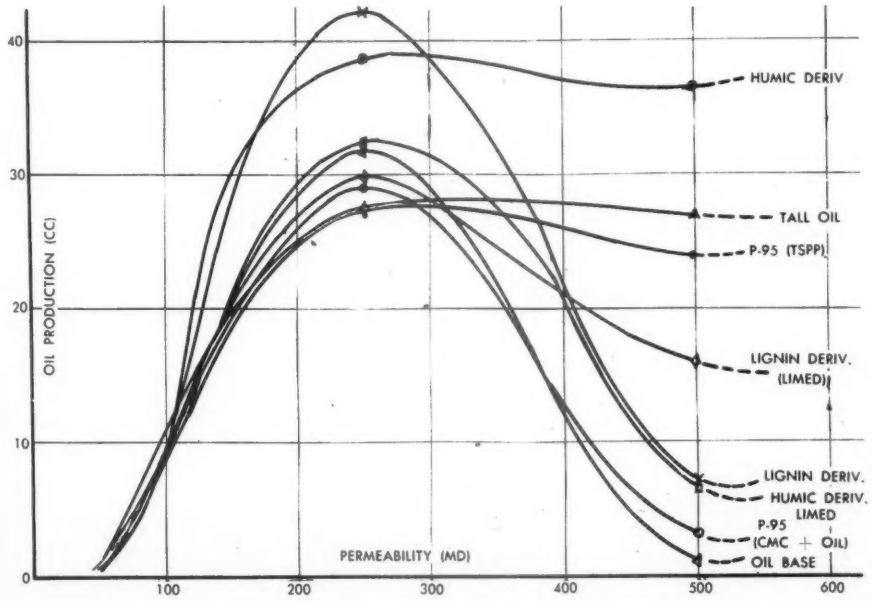

BODY, CHROMED 3½ O.D. BY 9 IN.
BAG, NEOPRENE, 500 ML. SELF SEALING LIP IN TOP FLANGE, 3 IN. I.D.
CORE HOLDER HOUSING AND FILTRATE SPOUT
FITS ZACHER FILTER PRESS
CORE
FILTRATE
SEALS
CORE HOLDER RUBBER-HYCAR-40 SHORE
LID TIGHTENING THREAD, FOUR PER INCH
PROTECTION RING FOR BAG FLANGE
LIP TIGHTENING RING, FAST, FOUR THREADS PER INCH

FIG. 6. Completion fluid tests—Permeability vs oil production.



1. By these tests formation damage by filtrate, over a long period of time, is not known. The filtrate may ultimately effect and rearrange movable and hydratable clays or shales thereby blocking (or unblocking) channels.
2. This test does not presume to duplicate hole conditions of pressure, heat, etc. The test actually compares one completion fluid with another against any core that duplicates, or is cut from the formation in question.

C. Actual Steps in Conducting Tests. Taking up the five steps of the test, in their order, the first is:

1. Extraction of core. This step may be omitted if test on actual core is desired upon taking from well. This would be the usual procedure. To establish performance tests for this process, however, alundum discs were substituted for cores. The three types were: 50 to 100; 200 to 300; and 400 to 600 millidarcys. In order to rerun cores, a Size A Soxhlet extractor was used with conventional organic solvents.

2. Saturate with connate water. Flood alundum cores with about 2000 pore volumes of connate or formation water. This was done with formation water from Ventura wells, by simply filling filter press and exerting pressure required. This was done to provide conditions usually encountered.[4]

3. Unblock saturated core with kerosine. Flush cores of water (so far as, or is, possible) with kerosine using same means as under Number 2.

4. Subject core to action of the mud or completion fluid. This is done at 100 psi pressure in the same filter press. The alundum cores used were 13 mm in length. Future work should include the longer types, of at least twice this length. Also performance data will include intermediate premeabilities.

5. Turn core to test production. Turn the core carefully and flush or "produce" with field crude. Record.

D. Discussion of Calibration of Instruments. The justification and value of a rig test that would embody a more significant measurement of the loss of filtrate, or mud, or both to a formation is very obvious. Recently, Dr. C. M. Beeson[2] said, "Probably the factor least generally accepted by the industry is the one involving the loss of mud to the formation.....". Interesting (if not astonishing) results were obtained by impressing the various type drilling fluids against alundum cores using a specially designed head for a filter press. (See picture and drawing.) Actual muds compared with this device were described in earlier paragraphs using routine filter press tests. These were tests obviously inconclusive for the purpose of testing for completion work.

The cores were first pushed into the neoprene rubber sleeve and saturated with several thousand pore volumes of connate or formation water using the filter press. Following this and by the

FIG. 7. Mud impurity testing kit for rig use.

FIG. 11. Other side of chemical kit with pilot testing reagents.

same procedure several thousand pore volumes of kerosine were forced through the core.

As stated above, each of the muds were placed opposite alundum cores with average permeabilities of 75, 250, and 500 millidarcys. The muds were impressed on the core face for 30 minutes. Then the core was carefully (so as not to injure the filter cake) reversed in the core holder and back flushed with 30 API Ventura crude oil. The production or the amount of oil passed through the core in a given time was noted. The results of the experiments are tabulated below and plotted in Fig. 6.

Discussion of Results

Many apparent inconsistencies appeared on our tests especially in the 500 millidarcy range. The amount of filtrate that entered the core was not successfully measured without damage to the core. Actual interest, however, was in the relative permeability to oil after treatment with the drilling fluid. The results from the back flushing with oil indicate in most cases that there was relatively little oil passed through the low permeability core, which was expected. There were relatively large amounts passed through the medium or 200 to 300 millidarcy range but as the permeability increased from this point, the production of oil decreased with some so-called good muds. This inconsistency of decreased production with increased permeability is probably due to the spurt action where whole mud actually enters the formation before bridging of the pores takes place. It is believed that with the 400 to 600 millidarcy cores, the capillaries are large enough to accommodate the fine particles and all. This, coupled with the low internal friction (viscosity), would serve to permit migration until equilibrium with pressure at 100 pounds per square or 6.8 atmospheres occurs. Thereafter movement stops and thixotropy would effect a permanent plug. That this critical pore channel is in the region of 400 to 600 millidarcys is consistent with Wright's and Dr. Beeson's[2] work. We note a "dome" shape in the curve, which may serve as a significant warning when encountered in actual practice. It would indicate that one must alter either the formation or the mud. The latter would appear to be indicated. It is most likely that, as the permeability increases beyond 600 millidarcys, the amount of oil production or flow would increase and the curve would behave as shown by the dotted lines of Fig. 6. The loose particles in pore spaces may rearrange to cause further plugging after some length of time, however. This possibility should be explored by extended flow tests with oil.

This test is in no way a simulation of subsurface conditions but is believed to be a more significant and time-saving filtration test of a completion fluid. Final conclusions cannot be drawn from the above results as a great deal more work will be necessary. The work on the syn-

TABLE 1. Effect of varying amounts of emulsifier on mud properties.

Emulsifier (lb per bbl)	NaOH (lb per bbl)	Weight (lb per cu ft)	Water loss (ml per 15 min)	Filter cake (mm per 15 min)	Viscosity (sec. 1000-500 ml)	pH
Lignin deriv.						
4	2	76	5.4	1.5	28	12.2
	2	76	5.0	1.5	28	12.1
8	2	76	3.2	1.2	28	12.2
	2	76	3.5	1.2	28	12.2
12	4	78	2.6	0.8	29	12.5
16	4	80	1.9	0.5	34	12.5
Humic deriv.						
4	2	75	4.9	1.2	29	12.3
	2	76	5.0	1.1	28	12.2
8	2	74	2.9	1.0	28	12.2
	2	75	3.0	1.0	29	12.2
12	4	75	2.5	0.7	30	12.5
16	4	75	1.5	Film	35	12.5
Tall oil soap						
4	..	71	3.7	0.5	28	9.0
	..	72	3.6	0.5	29	9.0
8	..	64	1.0	Film	30	9.0
	..	66	1.1	Film	29	9.0
Lignin deriv. (limed)						
4	2	79	9.5	4.0	32	12.5
8	2	78	6.5	2.5	31	12.5
12	4	78	3.1	1.5	34	13.0
16	4	80	2.4	1.0	33	13.2
Humic deriv. (limed)						
4	2	79	6.0	2.0	32	12.5
8	2	79	4.2	1.0	31	12.5
12	4	80	2.8	0.3	37	13.0
16	4	82	1.0	Film	46	13.0

General test conditions:
All emulsion muds contained 20 per cent of 30 gravity Ventura crude oil.
The clay was aged and blunged 30 days and made to a weight of 80 lb per cubic foot.
The base mud had a fluid loss of 9.1 ml in 15 minutes with filter cake of 1.7 mm.
Water used was Ventura tap and tests were run at room temperature or approximately 68 F.
Mixing was done by a specially designed chopper to exclude air occlusion.
All testing according to A.P.I. Code 29 except viscosity.

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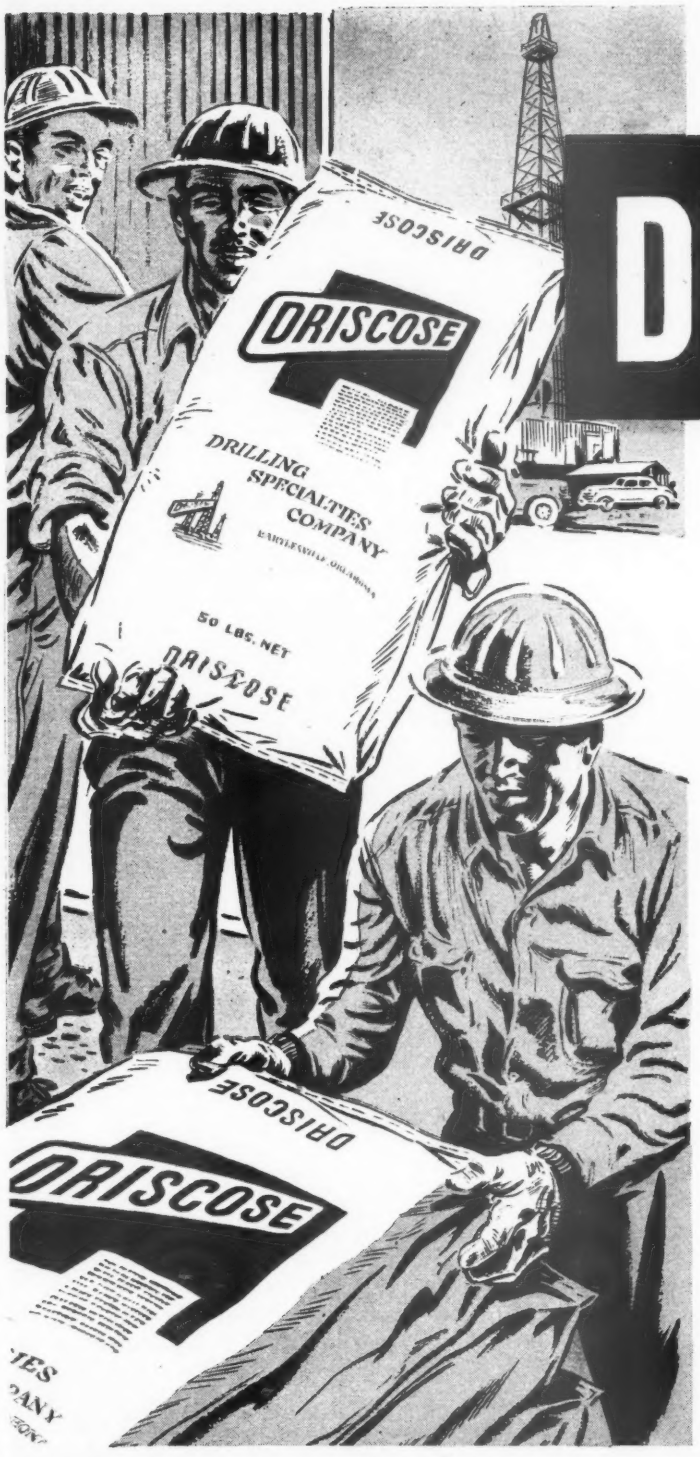
Drill with

DRISCOSE*



THIN, STRONG SHEATH. Drills operate more smoothly with less danger of sticking when Driscose forms a smooth, protective coating in the hole. Fewer ledges mean easier recovery of "fish" if twistoffs do occur. Fewer delays. Fewer operational headaches!

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DRILLING SPECIALTIES COMPANY

BARTLESVILLE, OKLAHOMA

TABLE 2. Tabulation showing performance data completion fluid testing procedure.

Type of mud and permeability (md)	Flushed with mud: cake thickness (mm)	Flushed with mud: mud penetration (mm)	Back flushed with oil: oil production (cc)	Back flushed with oil: clay production (cc)	Back flushed with oil: filtrate production (cc)	cake characteristic
P—95+½ lb per bbl TSPP						
50–100	1½	1.0	0.9	None	None	cake blistered
200–300	1¾	8.0	27.5	0.5	None	blown off, good cond.
400–600	1¾	13.0	23.9	0.2	None	blown off, good cond.
P—95+½ lb per bbl CMC+6% oil						
50–100	1¼	13.0	None	None	None	remained on core
200–300	1	2.0	29.0	None	0.3	blown off, good cond.
400–600	1¼	3–4.0	3.0	None	0.2	blown off, good cond.
Oil base type						
50–100	Film	1.0	2.1	None	None	no cake
200–300	Film	1.0	32.2	None	None	no cake
400–600	Film	2.0	1.2	None	None	no cake
Lignin deriv.						
50–100	1½	4.0	0.7	None	0.2	loose and soft
200–300	1	7.0	43.2	None	None	came off, not dissolved
400–600	1	10.0	6.5	0.2	0.5	came off dissolved
Humic deriv.						
50–100	1	10.0	0.1	None	None	loose and soft
200–300	1	7.0	38.7	0.1	None	loose and soft
400–600	1	7.0	36.5	0.1	None	loose and soft
Tall oil soap						
50–100	¾	2.0	None	None	None	soft, partially diss.
200–300	¾	3.0	27.6	0.3	0.1	came off, part. diss.
400–600	¾	4.0	27.0	0.1	0.2	came off, part. diss.
Lignin deriv. (limed)						
50–100	1½	2.0	None	None	None	no cake, dissolved
200–300	1½	4.0	30.1	0.05	None	no cake, dissolved
400–600	1½	3.0	16.0	0.05	None	no cake, dissolved
Humic deriv. (limed)						
50–100	1	2.0	0.2	0.2	None	dissolved
200–300	1¼	2.0	32.6	0.05	None	no cake, dissolved
400–600	1¼	2.0	6.8	0.05	None	no cake, dissolved

General test conditions:
Cores were flushed with mud for 30 minutes at 100 psi.
Cores were back flushed with oil for 75 seconds at 100 psi.

thetic cores serve merely to "zero-in" the instrument and to establish necessary performance character. It should be the policy to make daily checks on completion fluids in the field using this device against the lower permeability cores from 50 to 100 millidarcys. It is believed that the correct way to use this instrument is to make repeated tests while drilling in production zones. If such tests show deterioration of the mud, changes can be made immediately.

E. Results and Suggestions on Use. Where the plugging effect becomes apparent, due to capillaries being filled with mud (dome effect mentioned above), some possible remedies suggest themselves.

1. Provide inert material, such that matrix is possible, but which will not extensively alter the fluid loss.
2. Use of a surface tension reducing chemical.
3. Provide an oil soluble additive that will actually assist oil production. Arocolor is one material that will accomplish this. Experiments may show it would accomplish necessity suggested in (1) above. Aroclor was mentioned in 1941.

The suggestion that capillaries may be unplugged comes from a relation[8] that the pressure is inversely proportional to the square root of permeability. Thus, consider permeabilities of 100 millidarcys compared with 16 millidarcys:

$1/\sqrt{16} \div 1/\sqrt{100} = 1/4 \times 10/1 = 2\frac{1}{2}$ (times greater)

This instrument could be utilized to make quick checks on presence of hydratable or other damaging material in a formation, which reacts detrimentally to:

1. Filtrate from the drilling fluid.
2. Fluids leached from formation.
3. Formation, or connate waters.
4. Washing solutions used in remedial work.

To accomplish this, the presence and quantity of objectionable ions should be checked with some field kit adapted for such testing. A kit weighing only 8 lb has been adapted from the larger one described in 1945[5] and is shown in accompanying photographs.

Well washing fluids such as calcium chloride may work in a satisfactory manner. The action of such chemicals on cores, however, should be carefully checked as these ions could react to plug a formation, in some instances. The cationic material would, in this instance, actually reduce permeability by precipitating and cementing particles together.

As often happens, this work on completions has reopened a new line of research. Although it is a fact that most companies are working along these lines, the results of these recent tests suggest different methods of attack.

A hypothetical case in which above instrument could be employed would be as follows:

1. Before drilling-in to production zone, a core from a nearby well would be obtained. It is realized that formations differ, especially on the West Coast. In spite of this the formation would not differ so radically as to make it impossible to get a sufficient similarity. Failure to obtain these cores would make it necessary to substitute alundum, or synthetic ones, of like permeability.
2. The completion fluids contemplated would be impressed against the selected cores. Upon reversal of the cores, the mud with maximum ability to produce oil would be considered. An interesting sidelight was the trial of a chemically treated water-base mud. Upon production the oil literally lifted the filter cake making it swell or "blister".
3. While drilling in, the time would be used to check the completion fluid constantly. Changes not contemplated, by the well making various substances, could take place and if noted may be corrected.
4. In remedial or similar work, all drilling fluids, washing, or other surveying fluids for locating purposes should be checked. There are many fluids that could damage the formation for all time. This is not meant to be an indictment but merely an idea of a needed test.

Conclusions

The need of a procedure to test completion fluids rapidly is apparent. The work outlined herein is, at least, a step in this direction.

Some good, low fluid-loss muds plug uncontaminated synthetic cores at 400 to 600 millidarcys.

Remedies for such muds may not be too difficult.

Requirement for new line of research is indicated by these performances.

Even if higher fluid loss is present, some "matrix making" muds which build up a strong cake may complete a well better by avoiding plugging certain formations.

The ideal and all purpose mud for completions has not yet been discovered.

Acknowledgments

For the excellent help given so generously by Craig R. Norton and Melvin D. Somerton, the author gives thanks.

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* * *

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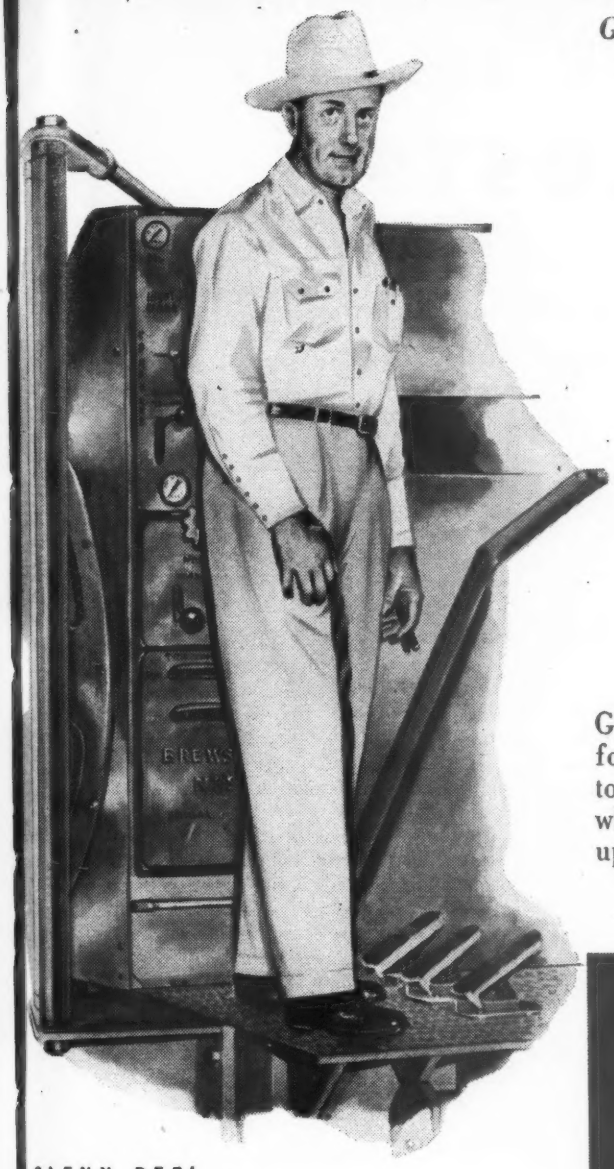
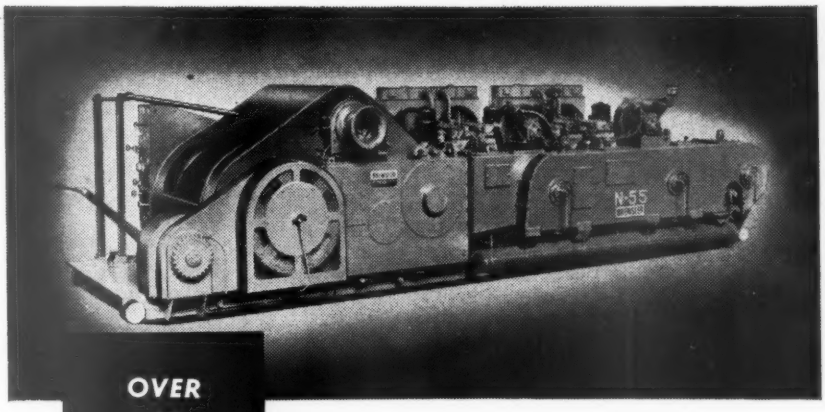


GLENN PEEL
Drilling Contractor



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DRILLING COSTS†

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DAVID SISKIND

A SURVEY undertaken jointly by the Labor Department's Bureau of Labor Statistics and the American Association of Oil Well Drilling Contractors makes available for the first time detailed information on expenditures for crude petroleum and natural gas drilling. Previously published data were limited to a few material and nonmaterial costs for specified wells or drilling activities. The 1939 Census of Crude Petroleum and Natural Gas was limited to costs incurred directly by oil and gas companies and covered only nine items. No distribution was made of contractor costs. The present study presents detailed expenditures for both drilling contractors and company owners. It was undertaken as part of a general study of transactions among all domestic industries in 1947 made by the Bureau of Labor statistics for the National Security Resources Board and the Department of Defense.

Collection of Information

Limitations on time and money and the complicated nature of the drilling industry made it necessary to adopt a judgment type sampling procedure. The sampling plan was developed in cooperation with the Drilling Contractors Association, with selection among correspondents chosen by the Association. The participants in the survey were selected to obtain coverage of both large and small companies and operators of both rotary and cable rigs. Consideration was also given to the volume of drilling activity in the various regions.

Two types of schedules were sent out to drilling contractors, one for rotary drilling operations and the second for cable drilling. Except for sections on "Drilling Fluid Materials" and "Drill Pipe Depreciation" in the rotary drilling schedule, the information requested on the schedules was identical. Furthermore, the distribution of costs for six depth ranges was requested for each type of drilling activity. (See Table 1). Most cooperating respondents reported their data in a similar fashion though some editing was necessary. The voluntary cooperation of the drilling contractors was outstanding.

The cost information supplied by drilling contractors was supplemented by additional data furnished by a number of cooperating petroleum companies. Since a substantial amount of materials, supplies and special oil field services are provided and paid for by the owner directly, payments to drilling contractors account for only a portion of total expenditures. In fact, drilling contractors' responsibility may range from a turn-key operation to supplying only the drilling equipment and manpower.[1] Hence, in order to make an integrated study of total costs, it was necessary to obtain information on expenditures by petroleum companies as well as expenditures by drilling contractors.

The data supplied by the cooperating petroleum companies on costs for materials and services exclusive of those supplied by the drilling contractors were not directly comparable for all items. There was an underlying similarity, however, and with some adjustments it was possible to utilize most of the information made available. It is felt that a reasonable distribution of costs was obtained.

Scope of Cost Coverage

This study is restricted to costs incurred in drilling new oil and gas wells and supplementary input and disposal wells. It covers the direct and indirect costs incurred from the time access roads are constructed by the drilling contractor or company owner and the trucks start rolling, until the well is either completed as a producer or is judged dry, casing pulled, hole capped, and the drilling equipment hauled away.

[1] Throughout this study, costs usually incurred by drilling contractors and those usually paid for directly by company owners were analyzed, insofar as possible, independently of each other. Although there is overlapping of costs, expenditures listed in the tables for contractors and owners do not contain any duplication of costs.

TABLE 1. Expenditures for crude petroleum and natural gas drilling by depth range, 1947

Item	Total	Under 3000 ft	3000 ft-4999 ft	5000 ft-6999 ft	7000 ft-8999 ft	9000 ft-11,999 ft	Over 12,000 ft
1. Total footage drilled (thousands)[1]	114,061.0	32,316.9	35,872.2	16,886.8	14,345.0	12,961.9	1,678.2
2. Cable footage drilled[2]	20,359.0	14,011.0	4,954.0	1,044.0	350.0	—	—
3. Rotary footage drilled	93,702.0	18,305.0	30,918.2	15,842.8	13,995.0	12,961.9	1,678.2
4. Average drilling contractor cost per foot[3]							
5. Cable drilling	—	$ 3.13	3.44	4.00	5.00	—	—
6. Rotary drilling	—	$ 3.52	4.43	6.14	6.99	8.57	16.83
7. Total drilling costs (thousands)	$ 602,653	108,291	154,009	101,451	99,575	111,083	28,244
8. Cable drilling	$ 66,822	43,854	17,042	4,176	1,750	—	—
9. Rotary drilling	$ 535,831	64,437	136,967	97,275	97,825	111,083	28,244
10. All other costs, exclusive of drilling contractor payments (thousands)[4]	$ 473,678	112,825	142,162	76,533	66,383	62,484	13,291
11. Total expenditures for oil and gas well drilling (thousands)	$1,076,331	221,116	296,171	177,984	165,958	173,567	41,535
12. Average cost, all wells	$ 32,496	—	—	—	—	—	—

[1] Total footage and distribution by depth is based upon data obtained from **Oil and Gas Journal**.

[2] The volume of cable drilling by depth range was estimated from information published in **Petroleum Data Book, 1947**. From this source, it was not possible to determine whether any cable drilling occurred beyond the 9000 ft level.

[3] This represents the average cost per foot derived from the schedules submitted by the drilling contractors. As explained in the text, these average drilling contractor costs were applied to total footage drilled.

[4] Includes all expenses incurred and payments made by the company owner, exclusive of payments to drilling contractors and comparable costs incurred by company drilling crews.

†By David Siskind of the Division of Interindustry Economics, Bureau of Labor Statistics. Kye Trout, director, Field and Engineering Activities, American Association of Oil Well Drilling Contractors, participated in the preparation of the schedules used to obtain cost data from oil well drilling contractors and assisted greatly in securing the cooperation of members of the industry.

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TABLE 2. Percentage distribution of expenditures by drilling contractors for crude petroleum and natural gas well drilling, 1947.

Item of expenditure	Percentage
Total	100.00
Labor and supervision	30.24
Wages	27.70
Social security payments	.59
Workmen's compensation	1.95
Rig supplies	3.98
General supplies	3.47
Hand tools	.51
Rig maintenance and repair	9.08
Equipment replacement parts	7.79
Service charges and costs	1.29
Rigging in and out	2.52
Rigging up	1.92
Tearing down	.60
Trucking	6.71
Road transportation, skidding	4.90
Spotting	1.81
Location, preparation work	.88
Bits, reamers, etc.	8.93
Fuel	2.95
Natural gas	.97
Butane	1.28
Diesel	.68
Other	.02
Water	1.06
Purchased	.42
Well drilling	.64
Drilling fluid	1.45
Lubricating oils and grease	1.31
Cement	.44
Tool rental	.73
Special services	.74
Rig depreciation	6.27
Drill pipe depreciation	3.50
Insurance	.86
Administrative overhead, profit, taxes, etc.	16.41
Management salaries	2.63
General office expenditures	2.91
All other	10.87
Miscellaneous drilling costs	1.94

A considerable sum is spent annually for exploratory purposes and although some drilling is involved in the process, these costs are outside the scope of this study. Also excluded are pumping and lifting operation costs subsequent to the completion of drilling, and the cost of reacidizing, reshooting, and other special oil field services involved in maintaining production of existing wells.

Computation of Total Expenditures

The first step in computing total expenditures for this industry was to estimate, by depth range, the volume of new footage drilled. The variation in contractor cost and company owner payments at different depths emphasized the necessity for this type of distribution. The basic source was a tabulation of completions by broad depth ranges obtained from the *Oil and Gas Journal*. This was supplemented by a tabulation of completions listed weekly in the same journal. The latter supplied sufficient data to estimate a distribution of wells drilled among six depth classes. The 114 million ft of hole drilled in 1947 was distributed into these six categories. (Table 1)

Since cost per foot of hole varies between rotary and cable drilling, the second step was to estimate separately the rotary and cable footage drilled within these depth ranges. The basic data for this calculation were obtained from material in *Petroleum Data Book, 1947*. From this source, it was possible to obtain some measure of the volume of cable drilling operations and to calculate the distribution by depth range. The difference between total footage and cable footage was assigned to rotary. Footage drilled by cable was estimated at 20.4 million and rotary drilling was allotted the remaining 93.7 million ft (Table 1). It was difficult to determine whether any cable drilling occurred at greater than the 9000 ft level in 1947. Since only two per cent of total cable drilling, however, was indicated to be in the 7000 ft and over range, the amount in the 9000 ft and over range was assumed to be negligible.

The average cost of drilling per foot of hole by depth range was obtained for rotary and cable drilling from a tabulation of the schedules submitted by the drilling contractors (Table 1). The average cost per foot for drilling contractors was applied to all drilling on the assumption that there would not be any substantial difference in cost per foot between contractor and company crew drilling. If there is any variation, company costs may tend to be higher because a company may drill in locations where for various reasons contractors are not available.

Distribution of expenditures for new oil and gas well drilling by industry classification, 1947.

(Thousands of dollars)

Industry code	Industry title	Expenditure
Total		1,076,331
	Non material costs	629,590
N168	Trucking	40,433
N197.1	Nonlife insurance	39,090
N204.3	Business services, n.e.c.	7,775
N205	Automobile repair services	24,305
N206.4	Miscellaneous repair services	28,557
—	Other nonmaterial expenditures and overhead costs[1]	489,430
	Material costs	446,741
1310	Crude petroleum and natural gas	8,242
1420, 1422, 1441	Crushed and broken limestone, crushed and broken stone, sand and gravel	3,099
1450	Clay, ceramic and refractory materials	10,991
1472	Chemical and fertilizer mineral mining	15,200
1961	Small arms ammunition	590
2094	Corn products	1,500
2297	Jute and cordage	3,780
2421	Sawmills and planing mills	614
2812	Alkalies and chlorine	1,080
2819	Inorganic chemicals	2,712
2823	Plastic materials	858
2826	Explosives	2,568
2852	Inorganic color pigments	870
2865	Natural dyeing and tanning materials	4,513
2898	Salt	848
2899	Chemical products, n.e.c.	1,170
2911	Petroleum refining	36,553
2951	Paving mixtures	1,842
3011	Tires and inner tubes	4,402
3241	Cement, hydraulic	18,052
3312	Steel works	219,439
3321	Iron foundries	4,528
3422-3425	Edge tools, hand tools, files, hand saws	3,236
3489	Wirework, n.e.c.	2,903
3494	Bolts, nuts, washers, etc.	3,012
3531	Construction and mining machinery	1,393
3532	Oil field machinery	58,535
3561	Pumps and compressors	661
3592	Fabricated pipe	768
4911	Electric light and power	1,809
9910	Motor vehicle replacement parts	4,555
5093	Waste materials[2]	24,000
—	All other materials[3]	2,418

[1] Includes wages, salaries, officers compensation, profits, taxes, depreciation charges, interest payments, rent, advertising, office expenses, etc.

[2] Reused pipe.

[3] Includes anthracite coal, bituminous coal, raw cane sugar, canvas products, cottonseed oil mills, compressed and liquified gases, lime, minerals (ground or treated), tin cans, tractors, wiring devices, electric lamps, electrical industrial apparatus, natural gas and manufactured gas.

The oil well companies provided expenditure data on wells where drilling contractors were engaged. It was possible to derive from their data the proportion that payments to drilling contractors were to total drilling expenditures by depth range. Costs other than payments to drilling contractors varied inversely with the increasing depth of the wells. Although the absolute value of materials and services supplied by the company owner increased with an increase in depth, they accounted for a decreasing proportion of total cost. These costs varied from approximately 51 per cent for wells under 3000 ft to an average of 32 per cent for those over 12,000 ft. In other words, at the over 12,000-ft level, average payments to the drilling contractors were equal to 68 per cent of total expenditures for the well. These ratios were used to establish the levels of direct company owner expenditures (Table 1). It is estimated that total expenditures for crude petroleum and natural gas drilling in 1947 amounted to $1,076,331,000, or an average cost of $32,496 per well.

Comparison with Other Industries

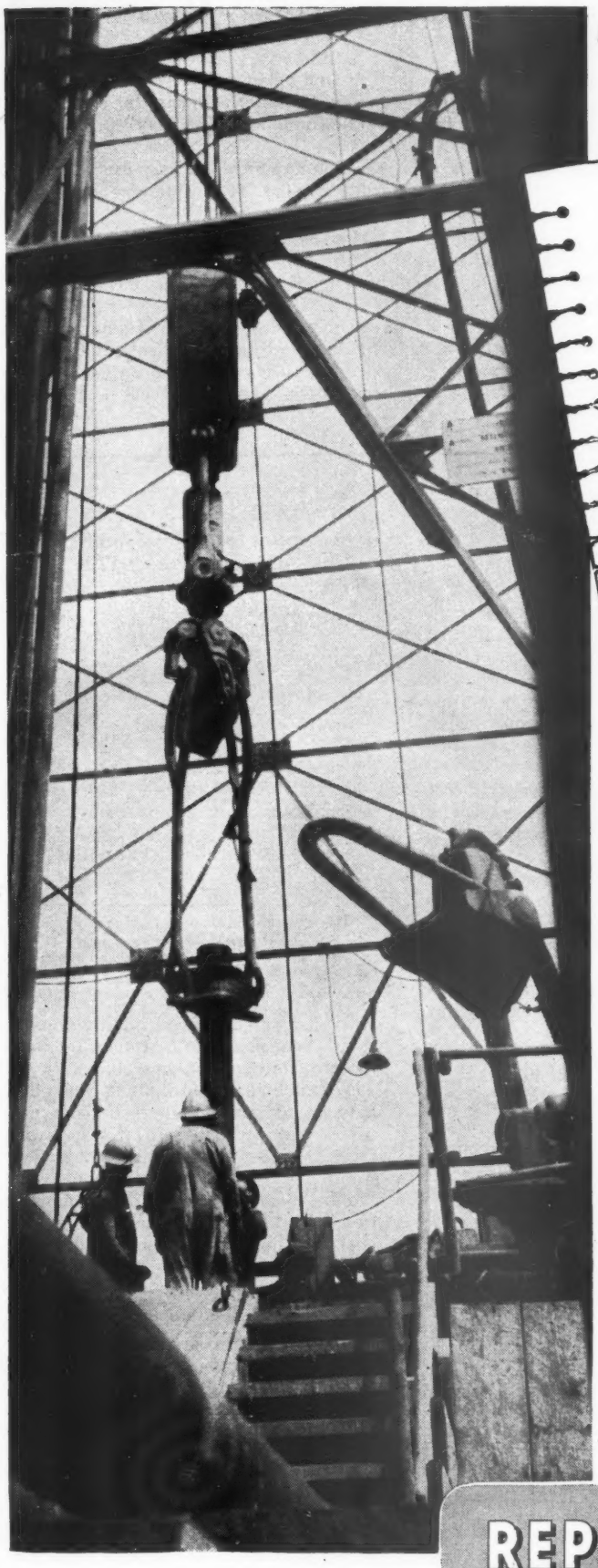
With annual expenditures for new drilling in 1947 of over $1 billion, this activity ranks as one of the most important forms of new capital investment in the country. According to the 1947 Census of Manufacturers, the manufacturing industries with the largest expenditures for new plant and equipment were the food and kindred products, and the chemicals and allied products industries with outlays of $821 and $811 million respectively. If data were available for the value of production equipment installed in new oil and gas wells,

TABLE 3. Estimated distribution of total expenditures incurred in the crude petroleum and natural gas drilling industry, 1947.

(Thousands of dollars)

Item of expenditure	Expenditure
Total	1,076,331
Labor and supervision	231,212
Wages	211,761
Social security payments	4,516
Workmen's compensation	14,935
Equipment	134,274
Maintenance and repair	62,204
Depreciation and rental charges	72,070
Supplies	63,473
Rig supplies	24,010
Other (fuel, water, non-rig, etc.)	39,463
Materials	377,052
Oil well casing	242,286
Bits, reamers, coreheads	58,535
Drilling fluid (muds)	37,993
Cement	18,052
Gravel, bitumens	4,941
Cast iron pipe and fittings	5,296
Hydrochloric acid	2,405
Nitroglycerine	1,650
Water well casing	1,154
Lumber	614
Bullets	590
Unallocated materials	3,536
Overhead and profit (including taxes)	137,805
Other costs*	132,515
Rigging in and out	15,219
Trucking	40,433
Special drilling services and costs	17,499
Testing and coring	18,083
Unallocated costs	41,281

* It was not possible to obtain detailed material and nonmaterial cost data for the activities included in this section. Therefore, the previously listed costs are understated to the extent that comparable material and nonmaterial costs are included in this section.



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the $1,076 million would be substantially increased and the difference between this industry and the two largest manufacturing industries would be even greater. Conceptually, oil and gas well drilling is sometimes considered a part of construction. Even in this vast activity oil and gas well drilling bulked large in 1947, ranking behind nonfarm residential, industrial, highway, farm, and residential additions and alterations.[2]

Distribution of Contractor and Company Costs

The detailed material and nonmaterial costs obtained from the survey were tabulated by type of drilling and depth range. These distributions were then applied to the dollar value totals set up for each category (Table 1). The totals were aggregated for all depth categories and a weighted percentage distribution was obtained of contractors expenditures (Table 2).

Most of the items on the schedules were easily tabulated. In a number of instances, however, contractors' records were set up so that some overlapping was inevitable. For example, the category "general supplies" included some lubricating oils and grease in addition to what is customarily included in that account by the contractors. The amount of duplication involved, however, is believed to have been small.

The distribution of the $473,678,000 in costs other than drilling contractor costs was based upon detailed information obtained from a number of petroleum companies. Some of the material costs appearing as drilling contractor costs also show up as company owner costs, e.g. cement, muds, fuels, etc. There is no duplication, however, since the companies reported only their own direct expenditures. These company expenditures were distributed as follows:

Item	Per cent
Casing	51.2
Cementing	9.3
Drilling fluid	6.1
Roads, clearing, preparation	4.6
Testing and coring	3.8
Perforating and shooting	2.8
Fuel and water pipe lines	2.8
Acidizing	2.5
Electricity, fuel, water	1.9
Coreheads, bits, etc.	1.0
Company supervision	2.0
Company overhead	2.9
Unallocated costs	9.1
Total	100.0

The expenditure for casing includes not only the cost of new casing but also the value assigned to reused pipe. An analysis of the 1947 Census of Manufactures value of shipments of casing, increased to allow for transportation costs and trade margins, supports the estimates obtained from the companies that in 1947 approximately 10 per cent of the total expenditure for casing was for reused pipe.

[2] If industrial construction was distributed into component manufacturing industries, and farm construction into its residential and service building segments, oil and gas well drilling would occupy fourth position.

Seashore Search for Oil

Drilling has stopped at 4353 ft in the test well being drilled just above high water mark on the dunes near Ainsdale-on-Sea, Southport, Lancashire, England, by the D'Arcy Exploration Company (the Anglo-Iranian Oil Company's prospecting subsidiary), AIOC reports.

Though oil has not been struck, the operation has provided very useful geological information which encourages further drilling. A considerable amount of geophysical exploration has been done in the Forby area.

The Ainsdale well was drilled as part of a plan to find the main reservoir from which has seeped the oil being produced from shallow wells three miles away at Forby. About 8400 tons of oil have been produced from this shallow field.

The data from the Ainsdale well appear to confirm that the original geophysical interpretation was substantially correct, and the oil indications found in the hole suggest that the program of oil research is proceeding on the right lines. A location for the next well has already been selected and will probably be drilled very shortly.

Total Expenditure Distribution

The detailed cost information for drilling contractor operations and company owner activities was combined to provide an estimated distribution of total expenditures incurred for crude petroleum and natural gas drilling in 1947. (Table 3). A breakdown of some of these items was obtained after additional research into secondary sources, and in cooperation with companies engaged in supplying special oil field services.

Labor, equipment and material costs accounted for almost 75 per cent of total expenditures. Supplies, overhead costs and miscellaneous services absorbed the remaining 25 per cent. The largest single expenditure, amounting to $242 million, was for casing. This was almost one-quarter of total expenditures and approximately two-thirds of total material costs. Wages accounted for slightly over one-fifth of total expenditures.

Drilling Muds and Fluids[3]

An interesting result of this study centered upon a comparative newcomer to the industry, drilling fluids or muds. As part of the general analysis for which this special survey was prepared, it was necessary to obtain consumption data on the specific components of drilling fluids. Although many articles have been written about the use and composition of fluids at various depths and for different types of strata, no attempt had been made to estimate the aggregate amounts of the components consumed during any given period. From diverse sources, such as the 1947 Census of Manufactures, the Minerals Year Book for 1947 of the Department of the Interior, import data, oil company information and various publications, the estimates presented in Table 4 were compiled.

Projection of Expenditures

A rough projection of total drilling expenditures for the years 1948 through 1951 can be made by applying completions data and the *Engineering News Record* construction cost index to the 1947 benchmark information. Since they may be of general interest, these estimates are presented in the following table. A more refined set of projections would require taking into account such factors as changes in the depth distribution of wells drilled, increase in offshore drilling, rise in the proportion of higher cost rotary wells, changes in mechanical and labor efficiency, and others.

[3] The special assistance of Walter F. Rogers, Gulf Oil Corporation, Houston Division Laboratory, in supplying information on this subject is gratefully acknowledged.

TABLE 4. Estimated distribution of expenditures for drilling fluids, by type of component, 1947.[1]

Item	Estimated consumption tons	Estimated expenditures thousands
Total	—	37,993
Barium sulfate	475,010	15,200
Bentonite	237,913	9,279
Quebracho	19,500	4,513
Starch	5,000	1,500
Clay, fresh and salt water[2]	60,590	1,212
Phosphate thinner	4,500	1,170
Caustic soda	8,000	1,080
Barium carbonate	6,000	870
Cellophane strips	954	858
Salt	30,312	848
Fullers earth[2]	15,618	500
Sodium silicate	3,452	307
Lime	7,000	252
Cottonseed hulls	3,000	150
Shredded fibers	1,200	144
Mica (dry ground)	1,000	110

[1] This represents cost of material at the site of operations.

[2] Clays are not purchased under these names. They are marketed under trade names, or are included as part of an end product mud.

Estimated total expenditures for crude petroleum and natural gas well drilling, 1947-1951.

Year	E.N.R. construction cost index (1947=100)[1]	Estimated average cost per well[2]	Number of completions[3]	Estimated expenditures[4] (millions)
1947	100	$32,496	33,122	$1,076
1948	111	36,070	39,778	1,435
1949	114	37,045	39,038	1,446
1950	123	39,970	43,279	1,730
1951	130	42,245	45,000	1,901

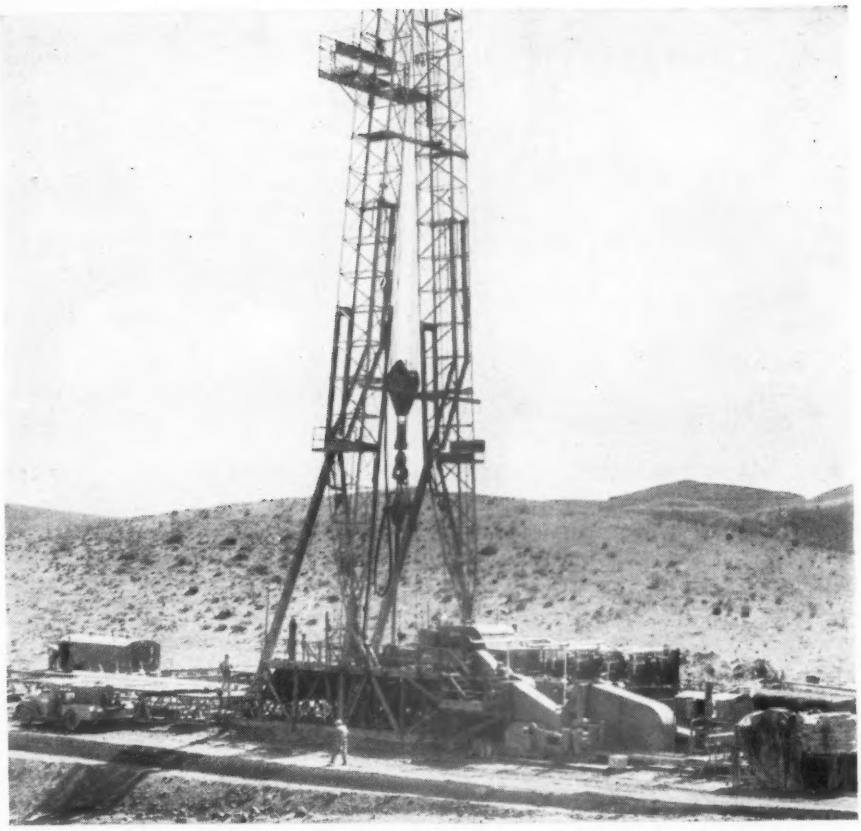
[1] From **Engineering News Record**. Preliminary estimate for 1951 by Bureau of Labor Statistics.

[2] Obtained by projecting 1947 figure through use of E.N.R. index.

[3] From **Drilling Contractor**. Preliminary estimate for 1951 by American Association of Oil Well Drilling Contractors.

[4] From two preceding columns.

* * *



General view of the Bell and Burden installation is shown here. The rig has an Ideco 138-foot full view mast, a unit rig U-30 drawworks, four LRIG-600 Cummins gas engines, Emsco pumps, and the Mid-Continent Supply multiple engine rig drive with swinging compound and swinging final drive.

Swinging Final Drive

New multiple engine drive completes operation without disconnecting chain

T. M. CONE

A RECENT development by Mid-Continent Supply Company has brought something entirely new into the oil fields as a companion to Mid - Continent's widely praised "swinging compounds."

The new Mid-Continent product is a swinging final drive, a drawworks input drive that pivots at number one engine skid and is transported as a complete assembly without disconnecting the chain. The flexible coupling at the drawworks input shaft is merely disconnected and the swinging final drive swung back into a vertical position and pinned there.

A bracket is attached to the drawworks to support one end of the swinging final drive and to provide alignment with the input shaft.

There is no sidepull on the drawworks input shaft and no brace required to prevent slack chain. The swinging final drive, when lowered into operating position, furnishes accurate spacing between drawworks and compound. There is no jacking of number one engine unit back and forth to put gaskets in or to make-up and tighten chain.

The swinging final drive and Mid-Continent compound chains are enclosed in oil tight, dustproof cases assuring long chain life. The first of these Mid-Continent compounds has been in operation for over four years and five others have been operating for over three years and still have the original chains in them.

The swinging drives are the key to fast moves, as by pivoting the drives to a vertical locked position, the skidded units are ready for the trucker. "You can take it apart without taking it apart," was the comment made by an oil company drilling superintendent who has been around the oil patch since before power rigs.

The first of the three swinging final drives now in operation was incorporated in a big rig delivered to Bell and Burden of Los Angeles in January, 1951. The rig drive or compound is a Mid-Continent Supply Company model 6240 with four Cummins LRIG-6 gas engines mounted on two skids and with a Swinging Compound connecting number two and three engines. The Unit Rig Company model U-30 drawworks, four engines, compound, and Swinging Final Drive are transported in three loads without breaking any chains or opening a chain drive case other than the rotary drive.

Montex Drilling Company of Fort Worth specified a Mid-Continent swinging final drive on their Unit Rig Company U-20 drawworks and Unit Rig Compound now operating in West Texas.

Durham Drilling Company, with headquarters in Midland, purchased a Mid-Continent Supply Company 3AE (any engine) Rig Drive, a three-engine drive for any engine, which has two swinging compounds and the swinging final drive. This drive is also behind a Unit Rig Company U-20 drawworks.

The swinging final drive is supplied

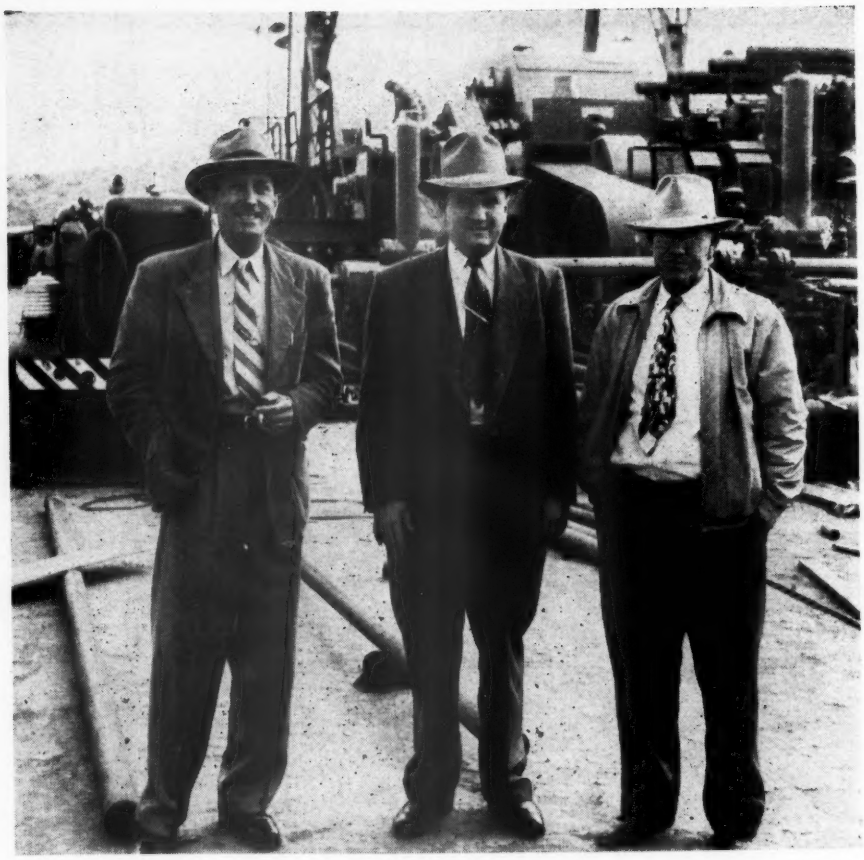
EXCLUSIVE

The Author

T. M. Cone, well known in engineering circles, has been chief designing engineer for Mid - Continent Supply Company for almost 14 years. He is a member of the Fort Worth Petroleum Engineers Club.

Attending high school and college in Wichita Falls, Texas, Cone worked from 1929 to 1937 with a manufacturer of drawworks and drilling equipment there. He also had experience with a Houston rig company as assistant chief engineer and with a drilling equipment manufacturing company in Shreveport as chief engineer before his employment with Mid-Continent Supply Company.

At Mid-Continent, Cone began working on the problems of power application peculiar to oil field installations. The first dual Cummins diesel engines, Mid-Continent multiple engine rig drives, and swinging final drive are among his contributions to the oil industry.



Pausing during rigging-up of the Bell and Burden rig, which featured the first Mid-Continent Swinging Final Drive are: A. W. White, service engineer for Unit Rig Company; L. T. Ratliff, Los Angeles district manager for Mid-Continent Supply Company, and H. A. Buchanan, manager of operations for Bell and Burden, Inc.

either with or without Fawick master clutch and neutral brake and with either 1½-in. pitch quadruple or 1½-in. sextuple chain. The bearings as well as the bearing houses and other parts are interchangeable with those of the swinging compounds. One spare housing will replace any bearing in the Mid-Continent compound or swinging final drive.

Both shaft assemblies of the swinging final drive, as in the Mid-Continent compounds, may be removed from the case as a complete assembly with all bearings still sealed off and without having to pull either of the flexible couplings.

Lubrication of the swinging final drive and swinging compounds is accomplished through spraying a stream of oil directly on the sprockets. No protruding pipes or fittings are mounted inside the case since channel bracing along the inside of the case also serves as an oil reservoir for pressure spray lubrication to the chain. In operation, oil is pumped into the channel reservoir, is sprayed on the sprockets, and drains back to the lowest part of the case where it is picked up by the pump again.

A plexiglass inspection plate on each side of the swinging drive case allows the operator to see at all times the effectiveness of the spray lubrication.

The master clutch, a 30-in. dual Fawick, and both the pump drive clutches, each 30-in. single Fawicks, are used as clutch couplings, permitting the sprockets and sheaves to be keyed to the shafts. The spherical roller bearings on the final drive shaft were selected to transmit the full horsepower to the engine units and these same bearings are used throughout the installation.

To date, 24 of the swinging rig drives have been delivered by Mid-Continent Supply Company. Of these, seven are operating on the Gulf Coast, seven in West Texas, three in South America, three in the Rocky Mountains, two in California, one in East Texas, and one in Florida.

The first display of the new multiple engine rig drive was at the International Petroleum Exposition in Tulsa, Okla-

PHOTOS BY T. M. CONE

Close-up view at the drawworks end of the Mid-Continent swinging final drive. Note the rugged support bracket and trunnions. Only the trunnion cap on each side and one set of coupling bolts need be removed to swing the drive to a vertical position. The spacer between halves of the coupling provides space for the looped air hose connection between shafts.

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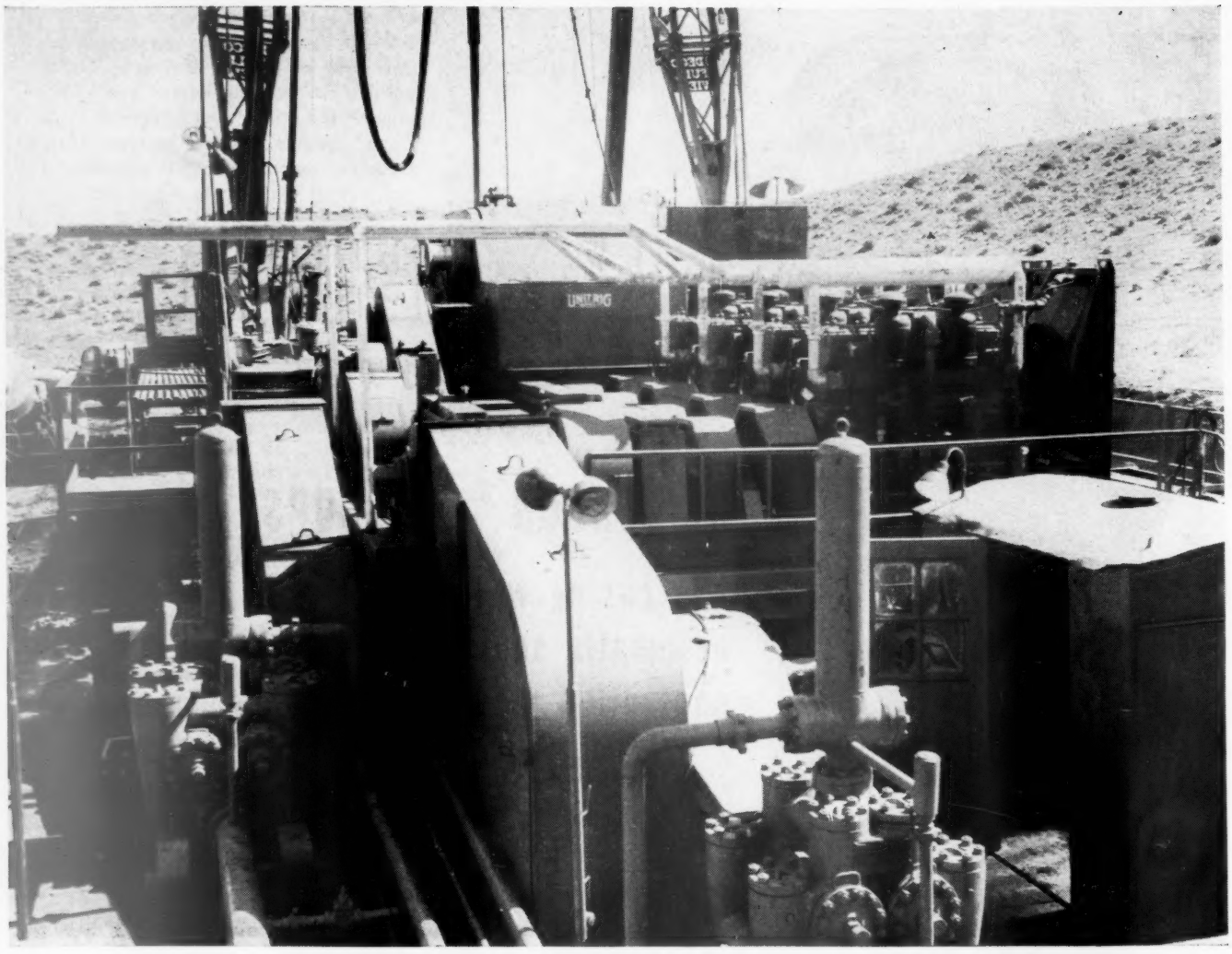
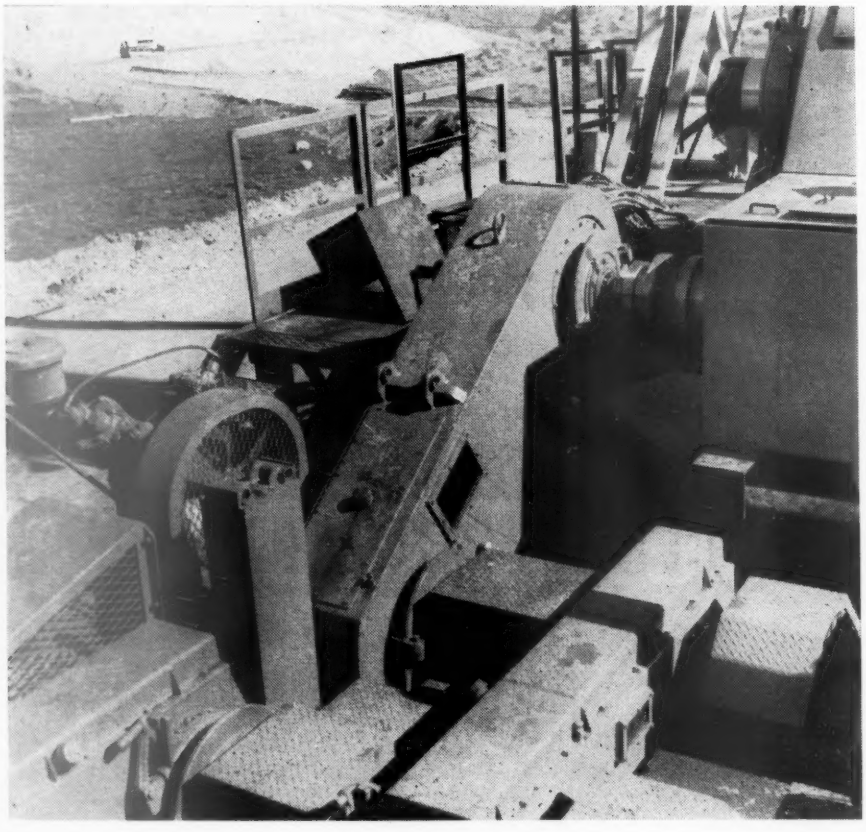


Rear view of a compact big rig. Note the step-type guard over the coupling between the Unit Rig U-30 drawworks and the Mid-Continent Supply swinging final Drive.



View as seen from above number three engine while rigging up the Bell and Burden rig. Note the post, between the Mid-Continent swinging compound and swinging final drive, to which both drives are pinned during moves.

homa, in 1948. Five rig drives, however. were already making friends in the field at that time. The multiple engine drives were first designed for the Model L Cummins diesel engine. They are now available for any engine presently used in oil field drilling.

With the Mid-Continent-Cummins rig drive, utilizing dual installations of the Cummins L engine, combinations of two, four, or six engines may be made. With the Mid-Continent AE (any engine) rig drive, as many engines may be combined as are desired, by the simple addition of compounds in tying in each extra engine.

The swinging final drive can be supplied for any of these rig drives. ★★

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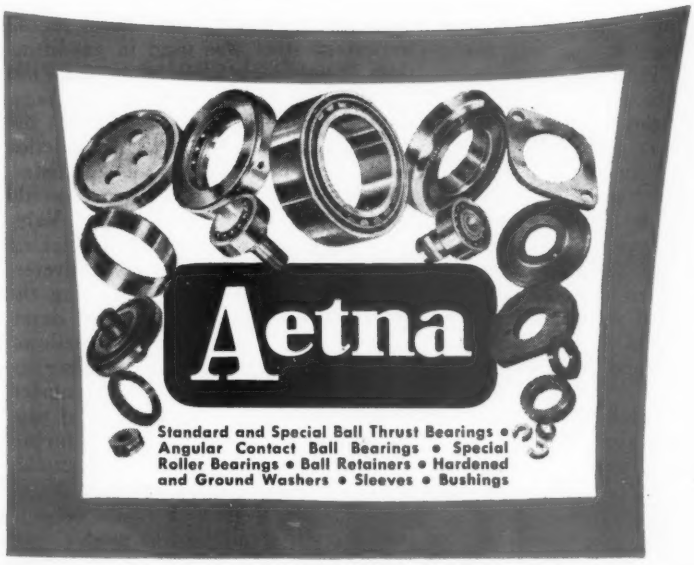
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The History of Gas Lift and Its Modern Application to the Petroleum Industry†

HARRY V. EICHER, JR.*

AIR-LIFT, the grandfather of modern gas-lift, was first used in Chemnity, Hungary, in 1782 to lift water from a flooded mine shaft. Large scale projects to lift water from mines were put to use in the latter part of the 19th century and the early part of the 20th century. Compressed air was used to empty water from flooded mines in Cuba, Mexico, Arizona, and Pennsylvania many times during this period. The most famous of these mines was the old Dominion Mine at Globe, Arizona, which had been flooded, believe it or not, by heavy rainfall. The water was jetted out by means of compressed air and steam. During a six-month period 40,000,000 bbl of water were lifted from this mine and in one month a record of 10,000,000 bbl were disposed of.

The first application of gas-lift in the petroleum industry occurred in a well in Pennsylvania in 1864. This well caused a sensation because it had failed to produce on the beam pump. Failure was possibly caused by gas locking. On gas-lift, the well produced between 50 and 60 bbl of fluid per day. Several articles were written on this amazing new way of lifting oil with gas and one author went so far as to say that this method of producing would replace the conventional beam pump. Several months later, gas-lift was tried on other nearby wells with only fair results, and eventually the entire field was on the beam.

In 1902-1905, compressed air was used at Goose Creek, Hull, Humble, Orange, West Columbia, and other fields in the Texas Gulf Coast where natural flow ceased or fluid volumes were not considered sufficient. In 1909, gas-lift was introduced in California at the Kern River field. During the twilight stage of the wells this method of production proved quite satisfactory, however, it eventually had to be replaced by the beam pump.

In the early days of air-lift, compressors were almost always driven by steam supplied from boilers fired with the produced oil. When the production declined and insufficient oil was produced to fire the boiler, air-lift was abandoned. In 1925, the Jones method of re-cycling gas was introduced in California. From this stemmed the change from compressed air to compressed gas in large scale gas-lift projects. Late in 1926, gas-lift was tried in the Seminole field in Oklahoma. Here for the first time studies were made on the efficiencies of gas-lift. Tests were made on the effect of bottom hole flowing pressure, size of eductor pipe and the effect of back pressure caused by high trap pressure, size and lengths of flow lines, right angle bends, and other relative data. About the same time, gas-lift was introduced in California at the Long Beach, Rosecrans, Huntington Beach, and Santa Fe fields. The success of gas-lift in the early days of these fields and in the Seminole field led to the introduction of gas-lift to West Texas and to various foreign countries, such as Peru, Romania, Trinidad, and Venezuela.

All gas-lift mentioned up to this time was that of the continuous flow type, generally classified as U-tubing. It was accomplished by injecting gas into the tubing and producing through casing annulus, injecting gas through the casing and producing through the tubing, or injecting gas through a small parallel string of tubing and producing through the regular tubing. These methods were a far cry from modern gas-lift, but quite successful in certain wells.

The decline in bottom hole pressures in the Seminole and Santa Fe fields introduced a new phase in gas-lifting: That of intermitting the gas into the well at the surface. In wells where the fluid volume was not great enough to justify continuous flow, this method saved large quantities of gas and in many cases increased fluid production.

In 1930, conservation laws in several states establishing well allowables paved the way for the use of jet collars, perforated tubing and differential flow valves, commonly called kick-off valves. Differential valves and jet collars had been put to limited use in 1926 in the Corpus Christi area and in the later phases of lifting in the Seminole and Santa Fe fields. The Oklahoma City field was the first where valves were used to any great extent, however. Wells in this field were placed on a monthly prorated allowable. The wells flowed naturally and in most cases the production for the month was made in several days and the wells were shut-in the remainder of the month. The normal decline in the bottom hole pressure and the encroachment of waste soon changed this picture and many of the wells needed aid before they began flowing again. To help the well unload its dead fluid, several differential valves were placed in the tubing string. When the well was shut in, formation gas accumulated in the casing annulus supplying enough energy to resume flow if the fluid heads were not too great. By placing the valves at certain intervals, this casing gas was allowed to enter the tubing, thus unloading the heavy fluid and putting the well in a flowing state. In time, gas had to be injected to keep the wells producing, and as the bottom hole pressure continued to decline and fluid production fell off, the wells were placed on surface controlled intermitting gas-lift. Several types of subsurface controlled intermitting gas-lift valves were used during this period. The Nixon surface controlled wire line valve was introduced here and the Acme macaroni valve was put to limited use. The Hughes plunger was used in many of these wells with a fair amount of success. Even so, the success in the gas-lift was not equal to the success of the beam pump, and the use of the pump became much greater.

With World II demanding so much more of our oil, gas-lift became more and more popular. Also, less of the all important steel was used in gas-lifting than in any other forms of artificial lift. At the close of the war, gas-lift manufacturers woke up to the fact that unless they could carry wells to depletion on gas-lift, it would not be a satisfactory method of artificial lift and would be eventually replaced by pumps. Valve manufacturers concentrated on making valves that would withstand the severest well conditions and abuse. During the war, bellows manufacturers had developed a very sturdy seamless bellows. This one item along with the development of new materials, such as tungsten carbid, has solved the problem of supplying a durable power section for all recognized valves. Extensive studies have been made to determine where and when gas-lift equipment should be used and where it should not be used.

†Presented before the Junior Group, Pacific Petroleum Chapter, American Institute of Mining and Metallurgical Engineers.

*Camco, Inc

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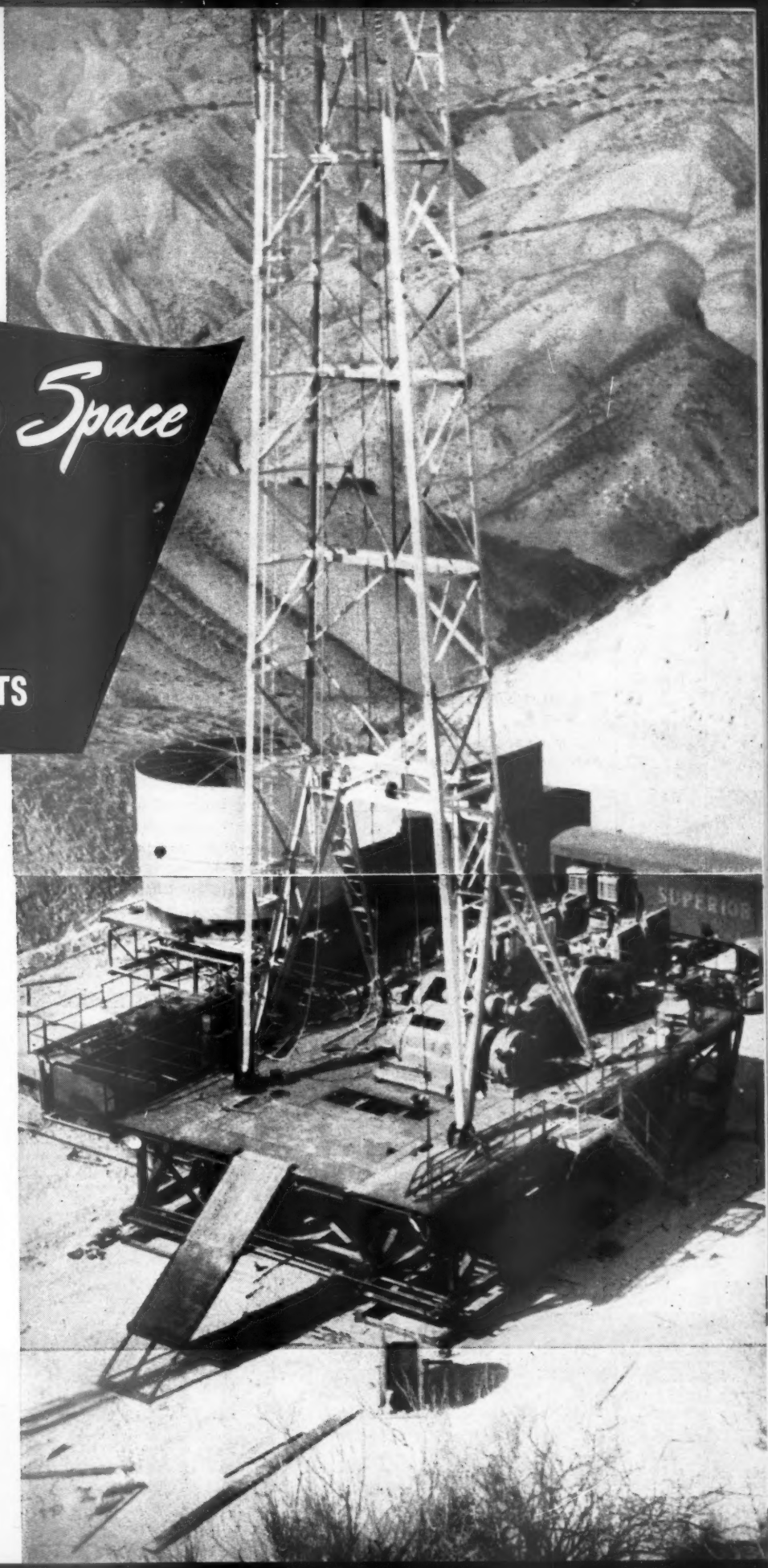

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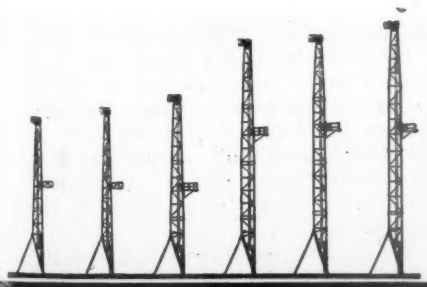

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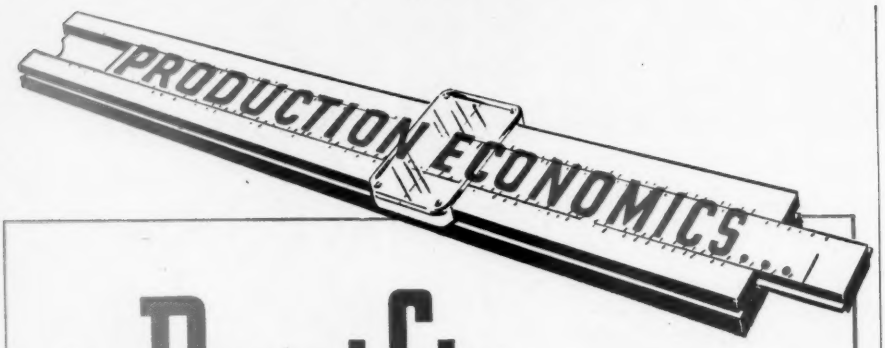

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Q	Can this condition be changed?	A	Yes — both can be activated and given earning power.
Q	How can they be activated?	A	Draw some of the money from the safe deposit box — purchase and install a Pacific Oil Well Plunger Pump in the well — pump the oil to the surface. MONEY IN CIRCULATION — OIL IN CIRCULATION — BOTH WITH POWER TO EARN.
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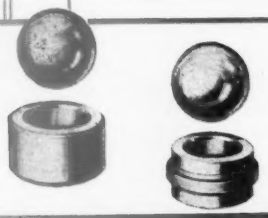

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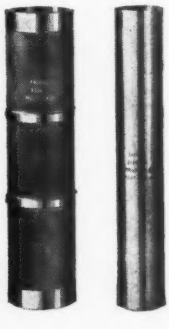

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Several important questions should be asked prior to even considering the use of the gas-lift. I will attempt to point out the most important of these:

1. *The gravity of the oil produced, the source of gas, and the percentage of water.*
2. *Is parafin a problem?*
3. *Is sand a problem?*
4. *What is the constituency of the fluid?*
5. *How much fluid will be desired?*
6. *How much gas pressure is available for kicking-off the well for working the well? How much gas volume can be counted on for continued operation?*
7. *What is the static bottom hole pressure of the well?*
8. *Do you know either the productivity index or the flowing bottom hole pressure?*
9. *What is the back pressure at the well head?*
10. *What is the bottom hole temperature?*
11. *What are the sizes of the tubing and casing?*

By analyzing the answers to the above questions, the gas-lift engineer should be able to recommend the type gas-lift that should be most applicable. He can also tell you whether continuous flow or intermittant flow type valves should be run and at what pressure these valves should be set.

Let us consider the gravity of the oil. Generally speaking, gas-lift should not be attempted in crudes with API gravities below 20 deg. An exception to this would be when the water percentage is above 85 per cent and large volumes of fluid must be lifted. Another exception to this general rule is where the well is producing pipe line oil, and water percentage will never be higher than 10 to 15 per cent. The reason for this caution is that low gravity crudes produced with water usually become emulsified. The addition of gas to this emulsion stirs this fluid to a very viscous substance closely resembling whipped cream and continuous gas-lift will not lift it. To overcome this problem, we recommend an intermitting flow installation.

Is parafin a problem? Constant flow installations would seldom be recommended unless large volumes of fluid, which would be produced at high tubing temperature, would be lifted. In small wells making parafin, only intermitting installations would be advised.

Generally speaking, wells troubled by sand are brought in by continuous flow. If the well is a small producer and continuous flow is uneconomical, we could commence intermitting it once the sand content fell below 2 or 3 per cent. If the fluid is mostly oil, as much as 8 to 10 per cent sand can be intermitted without the danger of bridging up the tubing.

We are also concerned with how much fluid is desired. This is the big question for first the operator will have to know how much the well is capable of mak-

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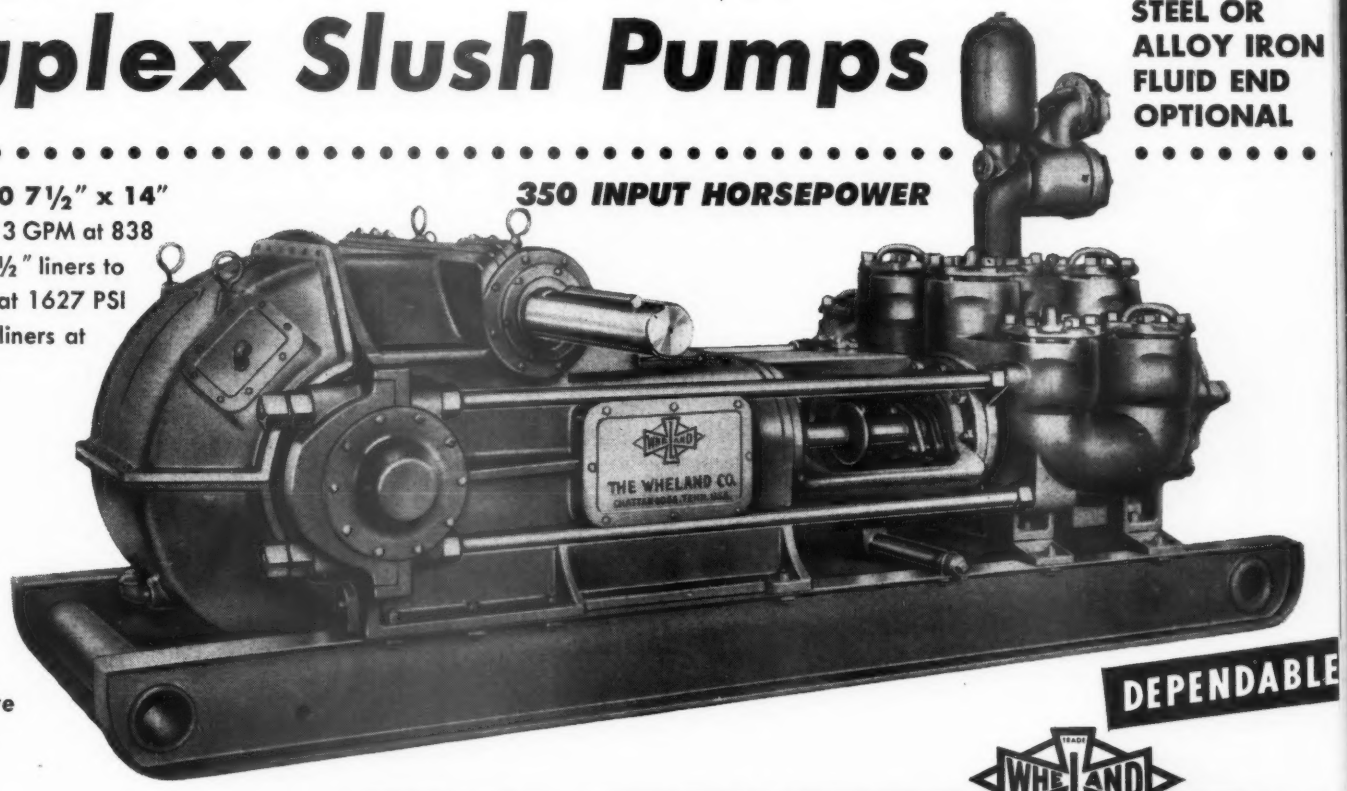

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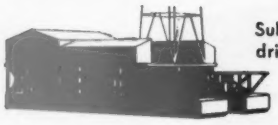
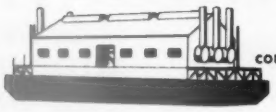


Submersible drill barges

Tugs



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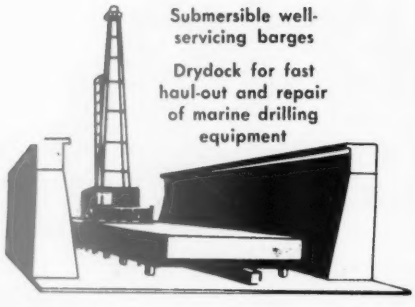

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ing, how far it is necessary to lift and then if you are going to have sufficient energy to move this amount of fluid. Too, you will decide on the type of lift, whether continuous or intermitting flow will give the most economical results. Your source of gas will be important for an intermitting flow normally you must have a large supply of gas available for a short interval of time.

Two of the gas-lift companies are now developing an intermitting valve that may use the well's casing annulus for the storage chamber needed for intermitting.

At this time, I will point out the amounts of fluid we have found to be the prerequisite for constant flow and the maximum operating depths that may be reached with certain pressures. The total amount of fluid to be produced daily by this type operation is a major efficiency factor, therefore, the operation is limited to wells with certain distinct characteristics. Wells should have a high fluid level and high productivity from a limited depth in order to operate most efficiently with this method.

It is very difficult to establish a minimum fluid production figure because of the many factors involved. Depth of operation, available pressure, fluid viscosity, and size of eductor tube are all of major importance. Under average conditions, however, it is possible to establish a broad rule by which wells might be classified as being in the continuous flow category. With 2-in. tubing, a minimum of 250 bbl total fluid per day might be efficiently produced and with 2½-in. tubing, a minimum of 400 bbl and with 3-in. tubing, a minimum of 600 bbl.

Generally speaking, quantities under these minimum figures should be produced by intermittent flow. There is, of course, an overlap between the minimum quantity under continuous flow and the maximum quantity under intermittent flow. Where such condition exists, an analysis of local conditions or the operator's preference generally governs the choice of operation selected.

Oklahoma Output Raised By Water Flood Projects

In the past decade and a half, Oklahoma has recovered 33,000,000 bbl of oil from 162 active and abandoned oil wells in that state, according to a release from the Bureau of Mines. About 450,000,000 bbl of water have been pumped into Oklahoma fields to recover oil that otherwise would have been lost.

Water flooding first began in Oklahoma in 1931, gained some popularity in 1935, and by 1941, oil production by water flooding was running at more than 3,000,000 bbl a year. After the war water flooding operations increased and by 1949, it was being tried in 25 of the state's 49 oil producing counties, covering 18,221 productive acres with a yield of more than 3,000,000 bbl of oil during the year.

The maximum possible fluid production is determined by the ability of the well to produce or the capacity of the eductor tube. When producing through 2-in. tubing, a maximum of 1200 to 1500 bbl per day might be expected. Through 2½-in. tubing, a maximum of 2600 to 3000 bbl should be produced and through 3-in. tubing, 4700 bbl. The estimated maximum production figures above are based on dead lift operations. Where a well has considerable reservoir energy, the possible maximum production may be greater.

The maximum operating depth of an aerating type of flow is a function of available operating pressure and minimum efficient flowing gradient that can be established and maintained in the fluid column. In order to understand this depth limitation, it is necessary that the principle of the method be understood.

Assume a vertical column of fluid 4000 ft high with an average gradient of .44 psi per foot of height. The column would exert a pressure of 4000 by .44 or 1760 psi at its base. If sufficient gas were injected and the column aerated to a point where the average gradient was .20 psi per foot of height the pressure at the base would be 4000 by .20 or 800 psi. If the average gradient were .10 per foot of height, the pressure at the base would be 4000 by .10 or 400 psi.

If an attempt were made to inject gas at the base point in either of the above examples, a pressure in excess of the fluid column base pressure would be required.

The maximum operating depth of this type flow under the existing surface conditions may be expressed in formula as follows:

$$D = \frac{P - Pt}{G}$$

Where:

D — maximum operating depth in feet from surface
P — surface operating pressure of valve—psi.
Pt — flowing tubing pressure—psi.
G — average flowing fluid gradient—psi/ft.

This formula is an approximation: As the gradient changes with distance from the surface and the weight of the casing gas column is not considered.

A factor to consider in any aeration type of flow is the result of excessive operating pressure. When higher pressures are used in an attempt to work lower in the hole, admission of additional gas lowers the flowing gradient of the tubing fluid column beyond a point of efficiency.

When this exists, a reduction in quantity of fluid lifted occurs because friction loss in the tubing creates back pressure to the extent that the flowing bottom hole pressure is raised instead of lowered. This tends to reduce the differential between reservoir pressure and flowing bottom hole pressure, thereby reducing the quantity of fluid flowing into the well bore. * * *

INTERNATIONAL STANDARDIZATION OF OIL FIELD EQUIPMENT†

A summary of API standardization that brought harmony, quality and interchangeability into petroleum equipment

C. A. YOUNG*

THE standardization of oil-field drilling and production equipment, by the Division of Production of the American Petroleum Institute, inaugurated in 1923 as a domestic activity, has expanded to the point where API standards are now recognized as international standards. The oil industry, therefore, has a very substantial stake in the field of international standardization.

There have been some interesting developments affecting the growth and recognition of these standards in foreign countries. The primary factor in this recognition has been the leadership demonstrated by the American oil industry in the development of drilling and production methods and in the application of those methods in foreign fields. The rotary system of drilling, originated and developed in the United States is the more popular, although the cable-tool system is still used in many areas both here and abroad. The rotary system is similar to an augur that rotates as it penetrates, as compared to the older drop-weight (cable-tool) method that chisels and pulverizes as it progresses.

The wide distribution of American equipment abroad carried with it API standards. Eventually many foreign manufacturers became interested in copying American designs, which involved the use of the necessary master gages on threaded products. A word about the scope of the Institute's standardization program and its administration is necessary here to provide a better understanding of the factors involved in the expansion of its use abroad.

This program, similar to those in many other industries, covers both quality and interchangeability. Although standards of quality are essential, the interchangeability of threaded and mating parts is of transcendent importance. The maintenance of interchangeability and the selection of sizes and types of threaded connections presented some interesting problems and required considerable study. Pipe, in the form of casing, tubing, and drill pipe, is a very vital item in drilling for oil and gas. These tubular products are threaded with the 60-deg V-thread, both roots and crests being rounded. The threaded connections on accessory equipment in the drill stem, such as tool-joints, drill collars, and tool bits, utilize a coarse pitch, steeply tapered thread having a truncated 60-deg thread form. Prior to API standardization there was no dependable interchangeability between these important connections of different manufacture. The complete chaos on drilling tool connections was solved by the adoption of complete specifications on a selected list of sizes of threads, including specifications on master gages. The key to maintaining interchangeability on drilling tools is the maintenance of accuracy of reference master gages owned by the various manufacturers. This was accomplished under the tutelage and guidance of the U. S. Bureau of Standards. The keystone of the arch was a set of grand master drilling tool gages deposited with the U. S. Bureau of Standards, with supplementary secondary masters deposited with official testing agencies in the Eastern, Mid-Continent and Pacific Coast regions of the United States, where manufacturers could test their master gages at stated intervals. When gages are beyond stated interchange tolerances, they must be reconditioned. In that way, no manufacturer can depart from this official standard for any great period. Experience has shown that the interval of three years now specified for retesting insures complete protection for maintaining the standards. In the case of pipe threads, grand master gages are not required as interchangeability can be maintained by direct measurement of the threaded elements of the manufacturers' reference gages. Annual reports from pipe manufacturers are required on the accuracy of their master gages. Illustrations of typical master gages are appended. It can now be stated that every important threaded connection in use in the producing branch has been standardized.

An important part of this international development is the Institute's system of identifying products that meet its specifications. It has an official registered monogram*—the use of which is granted to manufacturers under specified conditions. These conditions require a statement from the manufacturer detailing his qualifications and also an affidavit that the monogram will be used only on products which comply with a particular specification, and that material that does not comply will *not* be so marked. Compliance with API standards and marking privileges is entirely the responsibility of the manufacturer. Policing of compliance is done by the purchaser, either through commercial testing agencies or his own inspectors. There have been instances of non-compliance, which have been promptly rectified by the manufacturer, but there have been no cases of willful non-compliance.

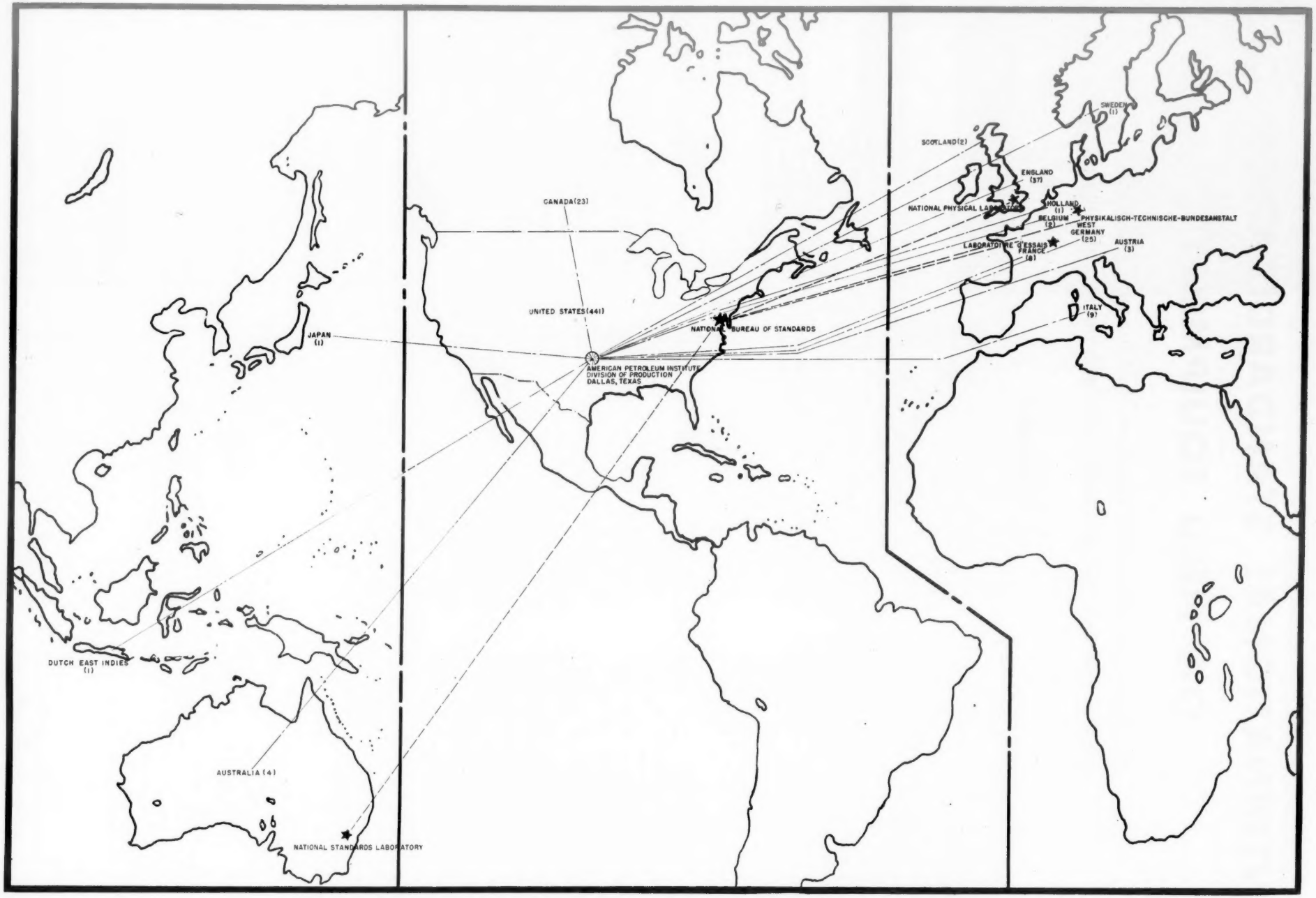
When foreign manufacturers became interested in API standards, the problem of testing and maintaining their master gages arose. This was solved through the appointment of foreign official certifying agencies that are the counterparts, in their respective countries, of our U. S. Bureau of Standards. Before appointment, the foreign testing agency was required to calibrate a gage and report on its accuracy. The gage was then sent to the U. S. Bureau of Standards where it was again calibrated and the results of these two tests then compared. Where differences occurred, they were adjusted by correspondence until there was complete agreement on the accuracy of the equipment and methods of measurement used by both. The U. S. Bureau of Standards is and has always been the court of last resort on accuracy. Its judgment is final. The oil industry is deeply appreciative of this service from the U. S. Bureau of Standards and gratefully acknowledges the fine spirit of cooperation it has always extended in our work.

This method of interchange testing solved the question of testing gages owned by foreign manufacturers. Adjustment of differences with the official English laboratory were minor and quickly solved. In other countries, the period of interchange testing required a much longer period of time. In one case, the U. S. Bureau of Standards supplied the foreign testing agency with drawings of equipment that had to be built before the Bureau could accept their measure-

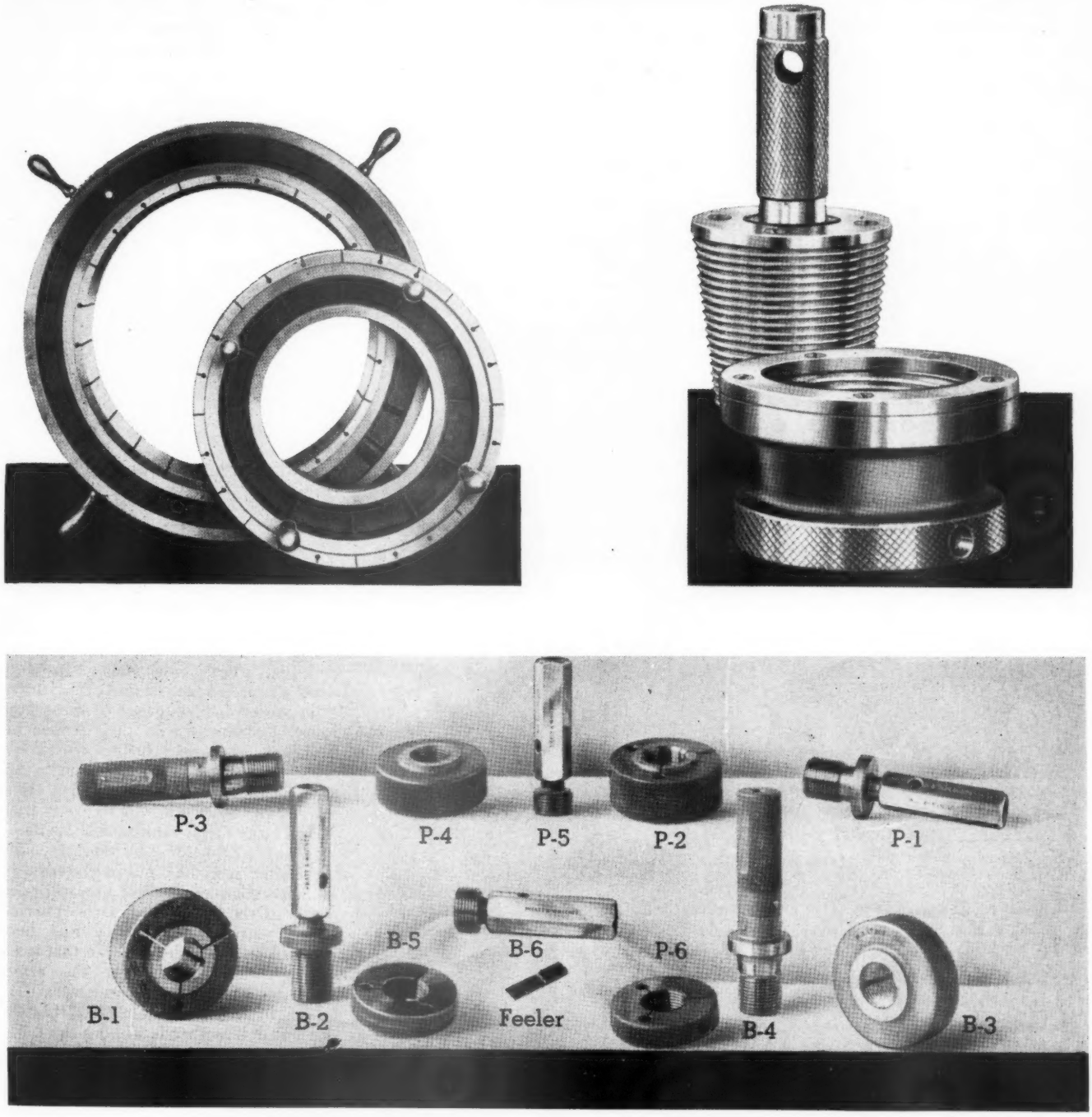
†Presented at the conference of executives of organization members, American Standards Association, New York, N. Y., October 22-24, 1951.

*Director, American Petroleum Institute, Division of Production, Dallas, Texas.

*This is formed with an A and P.



DISTRIBUTION OF MANUFACTURERS AUTHORIZED TO USE THE API MONOGRAM, SHOWING OFFICIAL GAGE CERTIFYING AGENCIES



Illustrations of typical master gages: Top left, casing gages; top right, rotary tool joint gages, and bottom, sucker rod gages.

ments. Today there are four such foreign testing agencies in Europe and Australia, as follows:

National Physical Laboratory, Teddington, Middlesex, England.

Physikalisch - Technische Bundesanstalt, Braunschweig, (West) Germany.

Laboratoire d'Essais du Conservatoire des Arts et Metiers, Paris, France.

National Standards Laboratory, Division of Meterology, Chippindale, New South Wales, Australia.

A system of reports on gages owned by manufacturers has been adopted and pedigree records are maintained in Dallas on the accuracy of the master gages owned by each manufacturer who has been authorized to use the API monogram. It is through this system of master gages, official testing agencies, and systematic reports, that interchangeability is maintained on an international basis.

The use of the Institute's monogram is not confined to threaded connections. It is also used on other products as well, for example, wire rope, derricks, mating pump parts, belting, steel chain, and others.

The accompanying map that illustrates the scope of the API standardization program as indicated by the location of authorized manufacturers and authorized testing laboratories. There are at present 441 manufacturers in the United States, and 115 manufacturers outside of the United States who have authority to use the API monogram.

A substantial number of API specifications are translated into German, French, and Italian. In the English speaking countries, API specifications have been adopted by several of the national standards agencies or have been used as the basis for the promulgation of related standards in which the

interchangeability provisions of API specifiications have been preserved.

Cooperation with foreign national standards organizations is maintained through the interchange of committee reports, specifications, and other publications. Because of the strategic and economic importance of petroleum, the current activity in drilling and production exceeds that of any prior period and this intensity is reflected in a very wide spread participation in our standardization program.

The value of the products made annually to API standards is on the order of $500,000,000, not taking into account material manufactured and distributed abroad. The savings of this program are incalculable but the fact that the component parts of a drilling rig can be purchased from manufacturers residing in 13 foreign countries and assembled at some distant point and drill an oil well is a practical demonstration of its efficacy. Recently there has been some striking evidence of the value of this program occasioned by the shortage of steel in this country. In the past year several thousand tons of tubular goods made in England, Germany, Belgium and France, have been imported into the United States and are being used in our domestic drilling operations. This foreign pipe interchanges perfectly with the American product.

The Institute also has been cooperating with the armed services of our government in the development of standards on storage tanks for oil and other products. Petroleum and its products are very important to our armed forces and the probable storage of these products is identical with their use in our domestic economy. During World War II several thousand tanks made to API specifications were used by the armed forces and when the war was over there was a large surplus that was immediately made available to the industry. Recently the army has indicated a need for a more complete interchangeability on some of the component parts. This detailed interchangeability has been worked out with the army so that today storage tanks for either the armed forces or domestic use are identical. The saving in producing material of this type for our defense needs without the building of special plants and equipment is apparent.

We are aware that there is an international standardization agency now functioning in an attempt to harmonize and standardize wherever possible on materials and equipment used in the international field. With the present rapid advances in speed in transportation and communication, the need for international standardization will undoubtedly increase and become more and more a necessity. Our reason for presenting this picture in the international field is to make our experiences available to this group in the hope that it might be of some interest and service. We are not attempting to make any suggestions in any way on the future activities of this international group other than to express our willingness to cooperate in any way we can in bringing about a better understanding and greater cooperation in our international relationships.

* * *

Geographical distribution of manufacturers authorized to use the API monogram

United States (441)	Number		Number
California	95	New Jersey	12
Colorado	3	New York	8
Connecticut	5	Ohio	49
Delaware	1	Oklahoma	34
Florida	1	Oregon	4
Idaho	1	Pennsylvania	60
Illinois	13	Rhode Island	2
Indiana	3	Texas	59
Louisiana	6	Tennessee	6
Kansas	2	Utah	2
Maryland	2	Virginia	2
Massachusetts	10	Washington	6
Michigan	17	West Virginia	16
Minnesota	1	Wisconsin	8
Missouri	12	Wyoming	1
Canada (21)		**Great Britain (39)**	
Alberta	1	England	37
British Columbia	3	Scotland	2
Manitoba	1		
Ontario	9	**Asia (2)**	
Quebec	7	Dutch East Indies	1
Continental Europe (49)		Japan	1
Austria	3		
Belgium	2	**Australia (4)**	
France	8	New South Wales	4
Germany	25		
Holland	1		
Italy	9		
Sweden	1		

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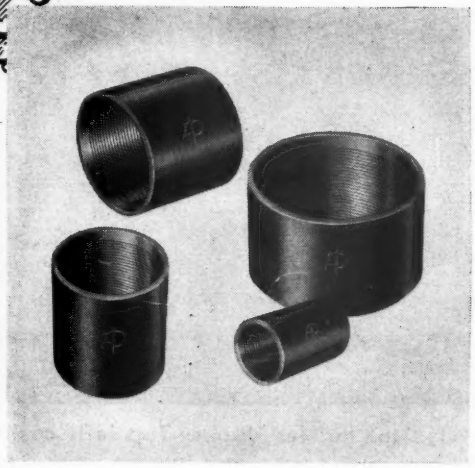

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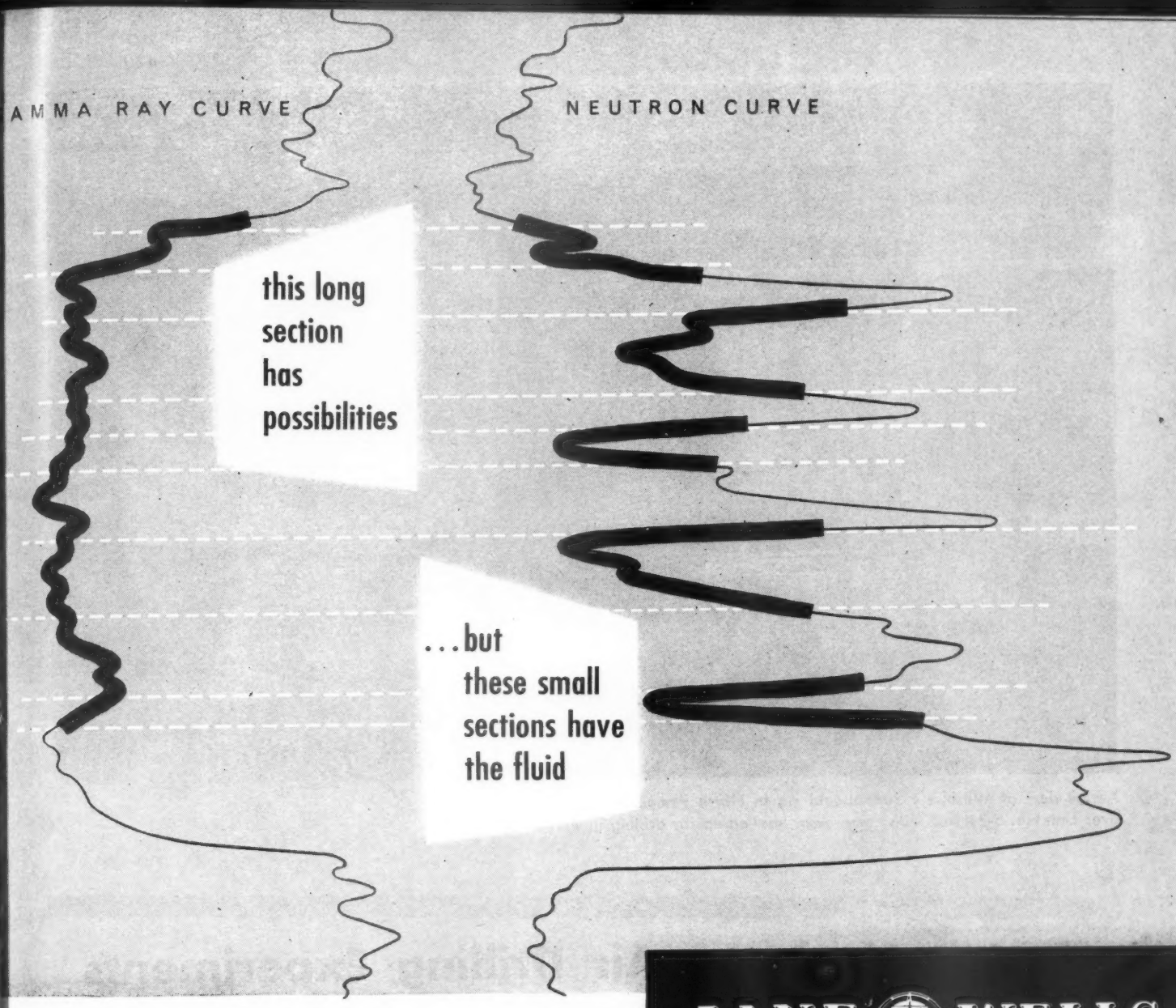

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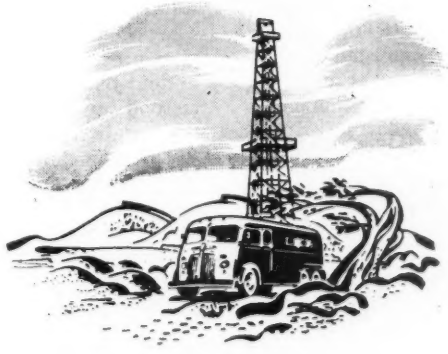

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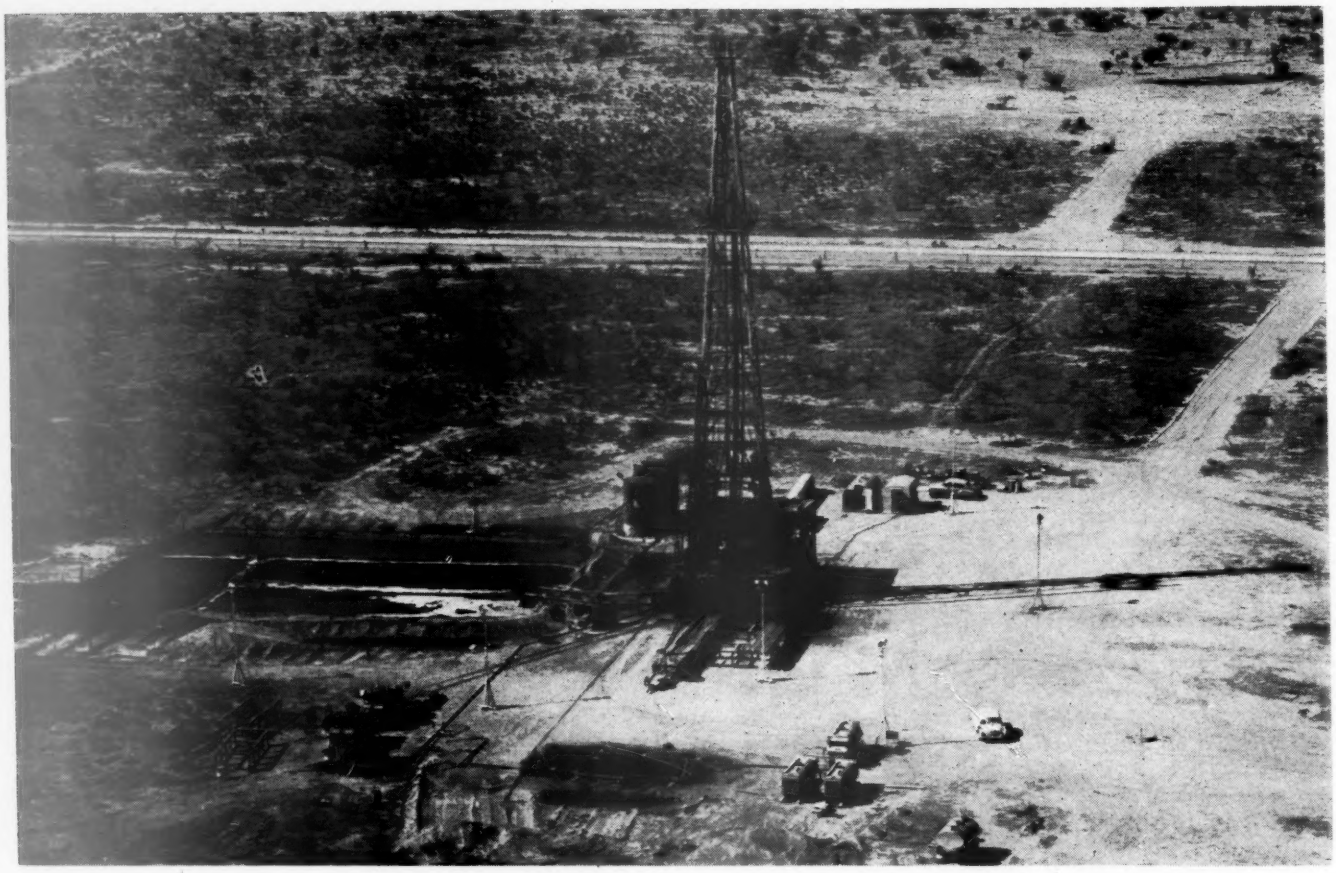

Aerial view of Wilshire's 50 national rig in North Pembrook Spraberry field over Unit No. 5-21 well with compressor hooked up for drilling in with air.

Report Made on Air Drilling Experiments

These are problems and results of drilling with air instead of fluid in West Texas, which add to the cumulating data on the method

RICHARD SNEDDON*

ALTHOUGH the results of air drilling attempts have not been too conclusive up to the moment, the few brief reports that have been published have occasioned so much comment among drilling engineers that the following resume of a paper recently presented at the Third Oil Recovery Conference of the Texas Petroleum Research Committee should be of wide interest. The paper was presented by O. H. Berry, Jr., and W. B. Quesenbury, Jr., of Wilshire Oil Company, and details the results of two experimental air drilling operations conducted by Penntex Oil Corporation and the Wilshire Company in Martin and Upton counties in West Texas.

The authors made no effort to wring dogmatic deductions from the accumulated data, but merely confined themselves to a factual account of their experiences, relating first the manner in which the operations were performed, the problems encountered along the way, and the total progress to date. They declared themselves open to conviction, but without any preconceived notion that air drilling is the ideal method by which to complete a well in the Spraberry formation.

The main purpose of the experiments was to define and evaluate a completion technique that would employ cable tool drilling with all its advantages and give comparable types and rates of penetration equivalent to those attained with rotary equipment. It was also the thought that air circulation might prove effective in overcoming lost circulation problems and in studying secondary recovery through the coring of depleted and semidepleted reservoirs. Finally, there was enough evidence to justify the belief that air could be satisfactorily used as a circulating fluid, and it was hoped that these experiments would develop at least some of the mechanics of such a completion practice.

EXCLUSIVE

The first of the experiments was conducted on an exploratory well, Penntex Oil Corporation's Ragland No. 1 in Martin County, where 922 ft of formation were drilled. This well was a nonproducer. The other experiment is still in progress at a North Pembrook development well, Wilshire Oil Company's Hunt No. 5-21, in Upton County. At the

*Pacific Coast Editor.

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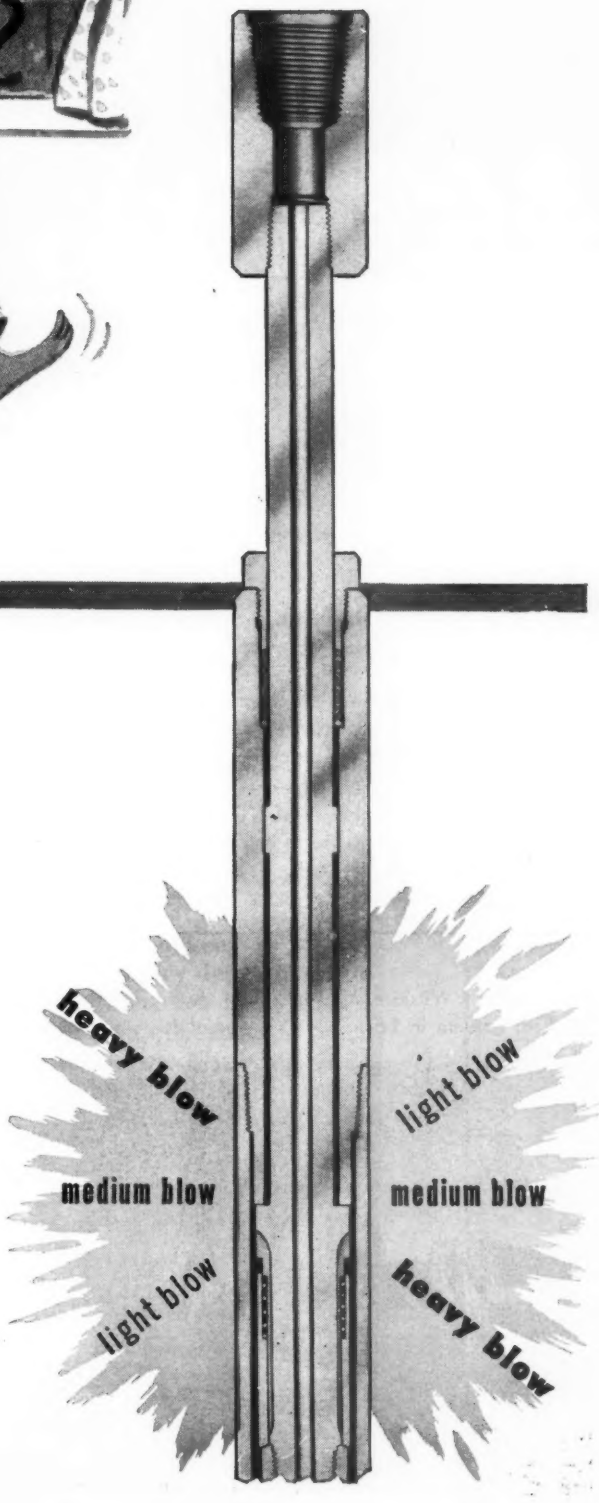

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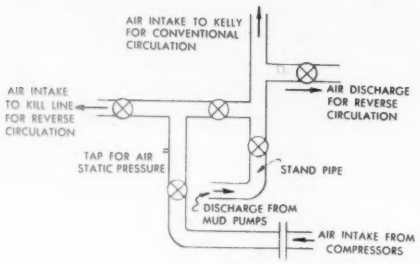
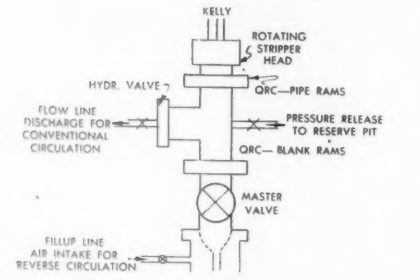
time the paper was presented, the Hunt well was the victim of a fishing job, but had successfully drilled 108 ft of formation below the oil string. There was actually a 4400 ft oil column in this hole, and during drilling operations oil was continuously jetted at the rate of approximately 10 bbl an hour from 7185 ft to a depth of 7198 ft.

Typical cuttings lifted by air stream rising.

Rig floor manifold hookup for conventional or reverse circulation with air or drilling fluid.


AIR INTAKE TO KELLY FOR CONVENTIONAL CIRCULATION
AIR INTAKE TO KILL LINE FOR REVERSE CIRCULATION
AIR DISCHARGE FOR REVERSE CIRCULATION
TAP FOR AIR STATIC PRESSURE
STAND PIPE
DISCHARGE FROM MUD PUMPS
AIR INTAKE FROM COMPRESSORS

Well control hookup.



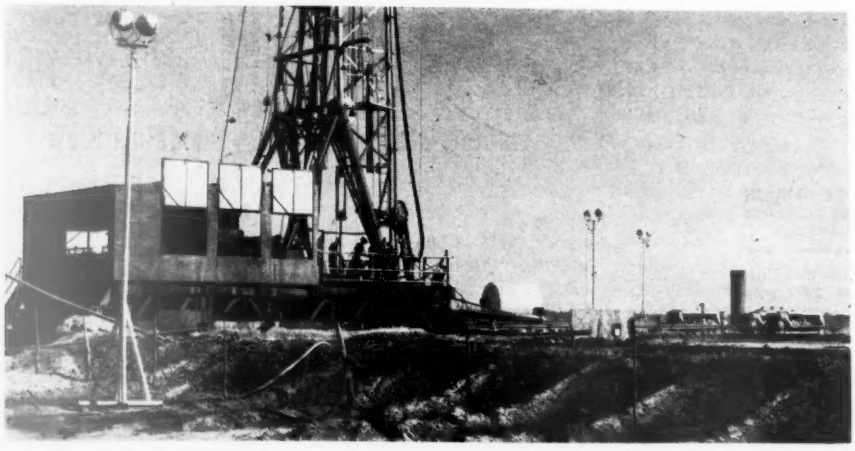
These experiments were initiated by Maurice A. Machris, executive vice president of Wilshire Oil and Frank B. Lake, vice president in charge of Mid-Continent operations, following some signal successes in overcoming severe lost circulation by aerating drilling fluid. Excellent results were obtained in the San Juan Basin of New Mexico with the circulation of natural gas, and it was this encouraging experience that prompted the experiments here described.

Consideration was given to the possibility of using natural gas or LPG as the circulating medium prior to the selection of air. No large supply of natural gas was available within reasonable distance of the well locations, however, and facilities for the handling of liquid natural gas in large volume were also minus, so air became the only choice.

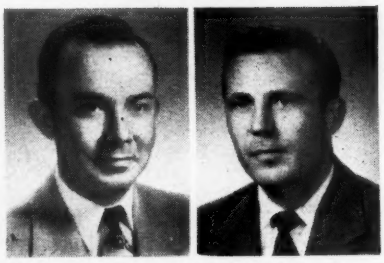
Air compression equipment was improvised and assembled capable of delivering 1,000,000 cu ft per day at a maximum pressure of 600 psig. At the Martin County operation this consisted of 10 small two-stage compressors of the type commonly used in construction work, and three larger single-stage booster compressors of the kind normally used for compressing natural gas in acidization work.

Practically the same hookup is being used in Upton County except that three 500 CFM two-stage compressors have been employed instead of the 10 small ones. This equipment was tied into a series of manifolds and an after cooler as shown in the accompanying flow diagram. During normal drilling operations, delivery from this set-up averaged 900,000 cu ft a day at about 200 psig and 150 F. It might be noted here that for future work of this kind Wilshire has purchased a 200 bhp, two-stage compressor that is designed to deliver 1,250,000 cu ft at 380 psig discharge. It should be added, however, that the choice of this particular piece of equipment was influenced somewhat by availability.

Side view of Wilshire's 50 National during air drilling operations. Vertical column in background is vessel for separation of well effluent.



The Engineers



W. B. Quesenbury, Jr. O. H. Berry, Jr.

O. H. Berry, Jr., was graduated from the Agricultural and Mechanical College of Texas in 1947 with a BS in petroleum engineering following a three year interruption of his education while serving as an engineering officer in the USNR. He commenced work as a petroleum engineer for standard Oil Company of Texas upon graduation and resigned as division petroleum engineer from this company early in 1951. He joined Wilshire Oil as district petroleum engineer in April, 1951.

William B. Quesenbury, Jr., was graduated from Texas A. & M. in 1949 with a petroleum engineering degree after spending two years with the U. S. Army Corps of Engineers. He entered the employ of Standard Oil Company of Texas and worked as petroleum engineer and well supervisor during Standard's development of its Scurry County field and later supervised water flood operations in its South Ward Field. He joined Wilshire Oil Company, Inc. this year as petroleum engineer.

Surface pressure control devices on both jobs consisted of a manually controlled master valve, two hydraulically actuated blowout preventers (one having blank rams), one hydraulically operated flow line valve, and a rotating stripper head. Subsurface pressure control equipment was incorporated in the Upton County drilling string. Although the need for such a step has not arisen yet, this affords a means of plugging the drilling string for purposes of making a connection or a trip if the well should begin to flow naturally. A landing nipple[1] was run in the lower portion of the string so that a plugged modified type "J" mandril could be lubricated and seated for a shut-off.

The oil string was cemented in a supposedly impervious zone overlying the fracturing at the top of the first Spraberry sand in both wells. At the Martin County well, the hole was jetted completely dry, and the first 48 ft of formation below 7-in. casing at 6620 ft was drilled by conventional circulation of air through a 6⅛-in. bit[2] with a reduced water course on 3½-in. drill pipe. A penetration rate of 5½ ft per hour was obtained with the application of only 4000 to 6000 lb on the bit and a rotating speed of 35 to 40 rpm. Returns at the surface, however, were in the form of dust, and cuttings were valueless from the standpoint of geologic analyses. It

[1]Otis, Type J.
[2]Hughes W 7 R.

1892–1952

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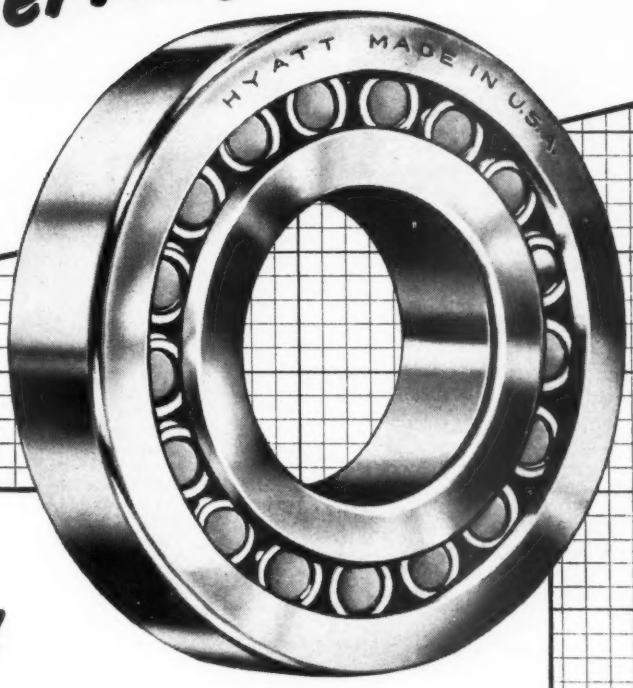

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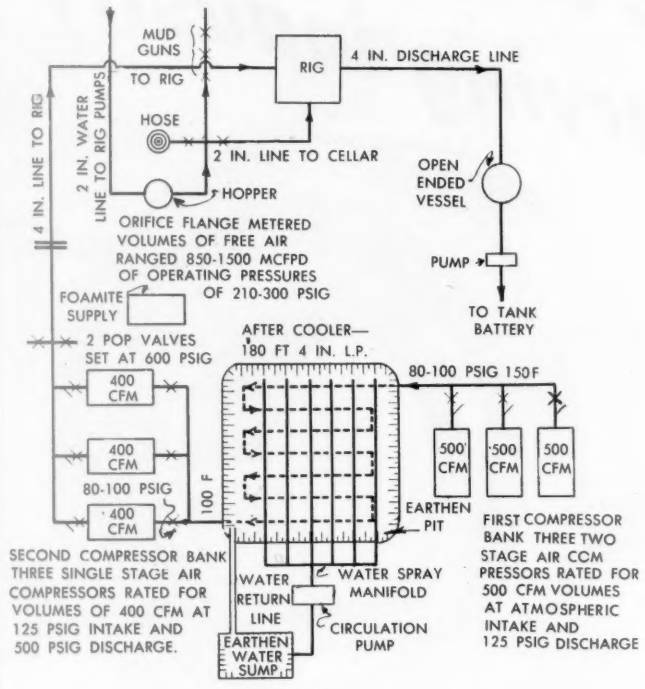
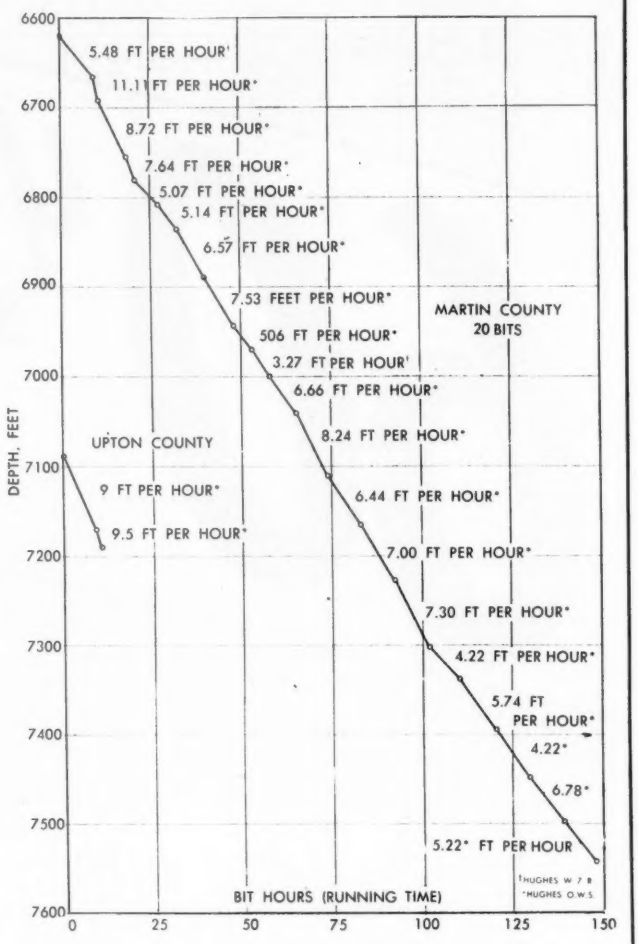

MUD GUNS
TO RIG
RIG
4 IN. DISCHARGE LINE
HOSE
2 IN. LINE TO CELLAR
OPEN ENDED VESSEL
HOPPER
ORIFICE FLANGE METERED VOLUMES OF FREE AIR RANGED 850-1500 MCFPD OF OPERATING PRESSURES OF 210-300 PSIG
PUMP
TO TANK BATTERY
4 IN. LINE TO RIG
2 IN. WATER LINE TO RIG PUMPS
FOAMITE SUPPLY
2 POP VALVES SET AT 600 PSIG
AFTER COOLER— 180 FT 4 IN. I.P.
80-100 PSIG 150F
400 CFM
400 CFM
80-100 PSIG
400 CFM
100 F
500 CFM
500 CFM
500 CFM
EARTHEN PIT
FIRST COMPRESSOR BANK THREE TWO STAGE AIR COM PRESSORS RATED FOR 500 CFM VOLUMES AT ATMOSPHERIC INTAKE AND 125 PSIG DISCHARGE
SECOND COMPRESSOR BANK THREE SINGLE STAGE AIR COMPRESSORS RATED FOR VOLUMES OF 400 CFM AT 125 PSIG INTAKE AND 500 PSIG DISCHARGE.
WATER RETURN LINE
WATER SPRAY MANIFOLD
CIRCULATION PUMP
EARTHEN WATER SUMP

Air drilling flow diagram.



Air drilling penetration rates.

also appeared that the hole was not being properly cleaned since, when the bit was pulled, considerable drag was noted.

After the Upper Spraberry had been subjected to the Hydrafrac process, a conventional 6⅛-in. bit[3] was run and drilling was resumed using reverse circulation of air through 3½-in. drill pipe. This proved very satisfactory in maintaining a clean hole and providing a succession of formation samples suitable for examination. Drilling in this manner progressed to a total depth of 7542 ft, holding an average weight on the bit of 12,000 lb with a rotating speed of 55 rpm.

It is of special interest that air circulation was very effective in cleaning out this well after shooting. A one hundred foot interval was cleaned out satisfactorily in 6½ hours after a selective shot of 100 qt. Surprisingly large particles of the bomb and shell cases together with formation fragments and shot gravel were lifted by reverse circulation.

At the Upton County job, 81 ft of formation below the oil string were drilled in 9 hours for a penetration rate of 9 ft per hour using reverse circulation. A string of 2½-in. tubing with two 4½-in. drill collars was rotated at 50 to 60 rpm carrying 10,000 lb on a 5⅝-in. bit.[3] The average surface air pressure was 250 psi and volume rate was about 1,000,000 cu ft per day. The bit was pulled after 81 ft for inspection and found to be in fairly good condition. No abnormal wear appeared to have taken place in the bearings as one would expect. The second bit of this type had a 19 ft penetration in 2 hours before plugging at a depth of 7190 ft. Upon pulling this bit two stands of oil were recovered and the plugged bit and bottom drill collar undoubtedly resulted from this initial fluid. As a matter of general interest, the top of the first Spraberry sand was found at 7148 (–4417) by sample correlation, but no odor of gas or oil staining was noted until a depth of 7185 ft had been reached. Two more bits[4] were run but became plugged before any hole could be cut. A skirted bit[2] was then run and had cut 8 ft of hole in 2 hours when the tubing twisted off at a depth of 5750 ft and at the time this was written, a fishing job was in progress.

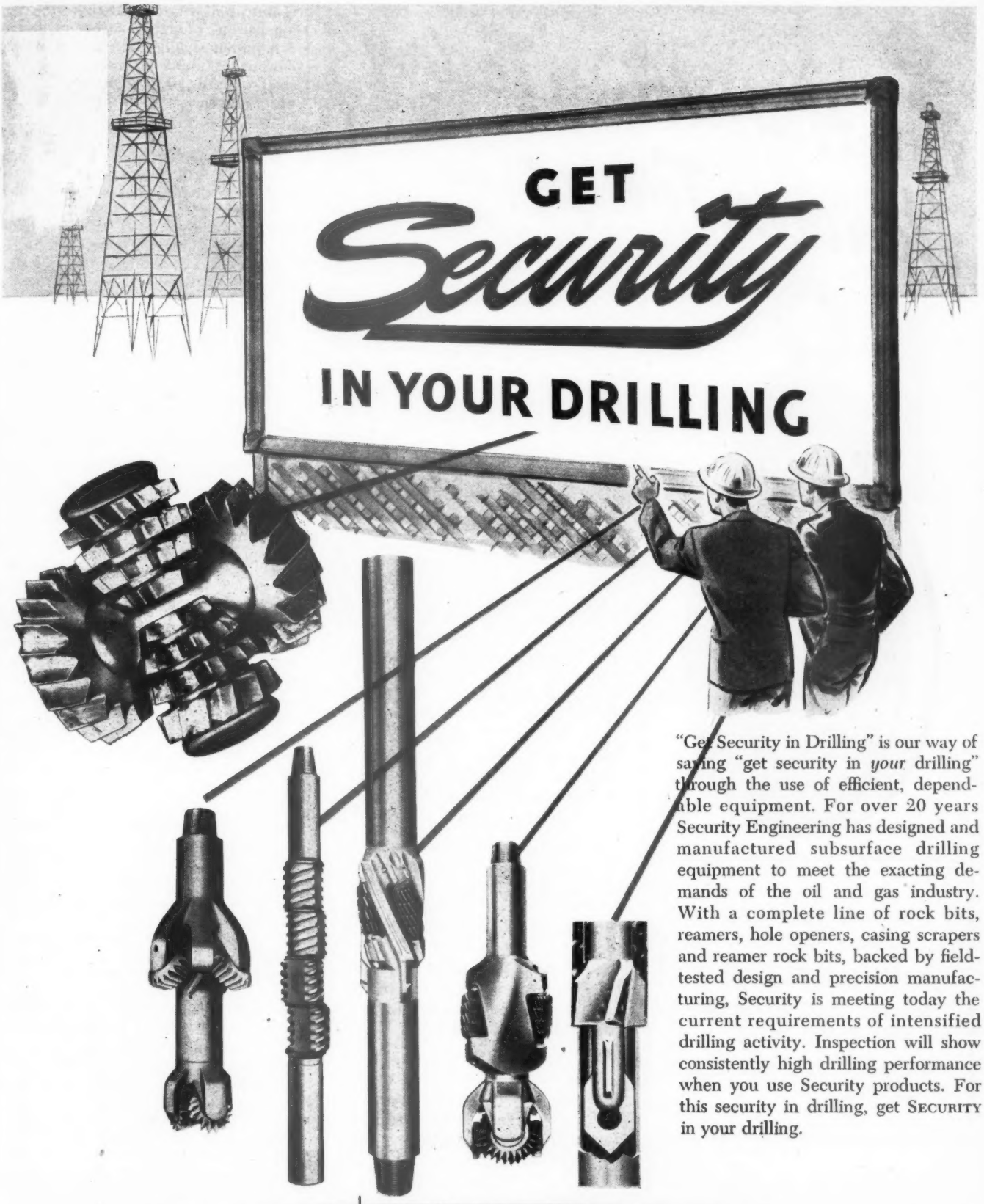
In drilling the shale sections below the casing seat and above the Spraberry sand top in both wells, a small amount of drilling mud was detected in the air discharge. This fluid might have leaked from behind the oil string or may have resulted from vertical fracturing through the casing seat. Its actual source had at this writing, however, not been determined.

Weighing the different problems encountered during the course of these operations, the plugging tendency of the drill collars and the bit at the Upton County job has been of greatest concern. No difficulty developed with circulation in drilling from the casing shoe at 7090 ft to a depth of approximately 7185 ft where oil was first noted in the flow lines. The tubing did not plug and it showed no adhering particles, but on two occasions, after reaming to bottom, the bottom drill collar and bit were plugged.

An effort to remedy this condition by the use of a skirted rock bit[2] was attempted. It was hoped that with such a tool all particles would be forced through the bit cones, thus reducing their size and eventually eliminating the plug. The actual result of this departure, however, remains unknown because of a twist-off. None of this bottom hole plugging was noted in the Martin

[3]Hughes O.W.S.

[4]Hughes OWS and Reed 2 C.



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County well, but several times the tubing became plugged because of the accumulation of adhering particles up and down the tubing string. Only a very small quantity of fluid entered this well while entrance of fluid into the Upton County well was at a rate of 10 bbl of oil an hour.

The ordinarily laborious and time consuming task of clearing the hole of fluid other than air has been eased and expedited by the use of three pressure flow valves[5] in the drill string at depths of 5000, 5900, and 6600 ft. These valves set at opening pressures of 550, 525, and 515 psi respectively have displaced a 2100 ft oil column from a total depth of 7200 ft in 3 hours following a trip.

The education of the drilling crew personnel to the problems encountered when air is used as a circulating medium presented no particular difficulty. It was largely a matter of becoming familiar with the functions of the various valves and with the process of bleeding off large volumes of air at high pressures. Close supervision had to be exercised, of course, until this familiarity had been acquired, but the fact that no injuries have occurred up to the present time is evidence that the crews fully understand the operation.

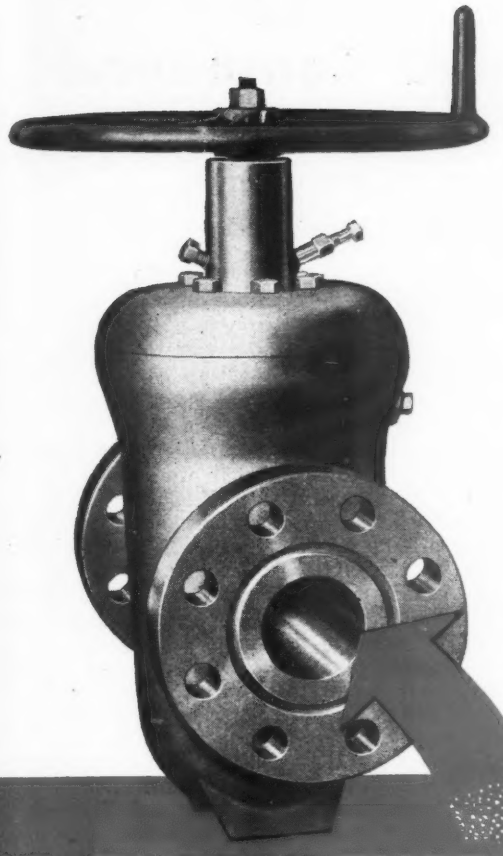
One of the questions that always pops up in any discussion of air drilling is the matter of safety. What hazards are involved, and how may they best be reduced or eliminated? The preceding paragraph answers the question so far as danger to personnel, under proper supervision and instruction, is concerned. Before operations were begun on the two projects described, however, an insurance company was consulted about coverage of the rig with respect to new and increased hazards. The opinion was expressed by the company that the use of air introduced no more hazard than does the use of oil.

It is probable that the only real danger lies in the discharged oil spray becoming ignited by some means. To reduce this danger to negligible proportions, flood lights have been mounted around the rig at distances of not less than 100 ft, which allows the extinguishment of all rig lights. To be doubly safe, the well effluent is directed to an open vessel about 500 ft away from rig.

The authors are duly modest about the immediate accomplishments of these experiments, but are nonetheless satisfied on the whole with the results. They contend that though their efforts have not been entirely successful, they have been sufficiently encouraging to justify further investigation of air circulation as an aid in completion practice. Meantime, Maurice A. Machris, Frank B. Lake, and Wilshire Oil Company are to be congratulated on the institution of this bit of engineering research. It is on such scientific stepping stones as this that the petroleum industry continues to increase its productivity and to maintain the technological greatness for which it has become justifiably noted.

[5]Garrett Type "O".

* * *



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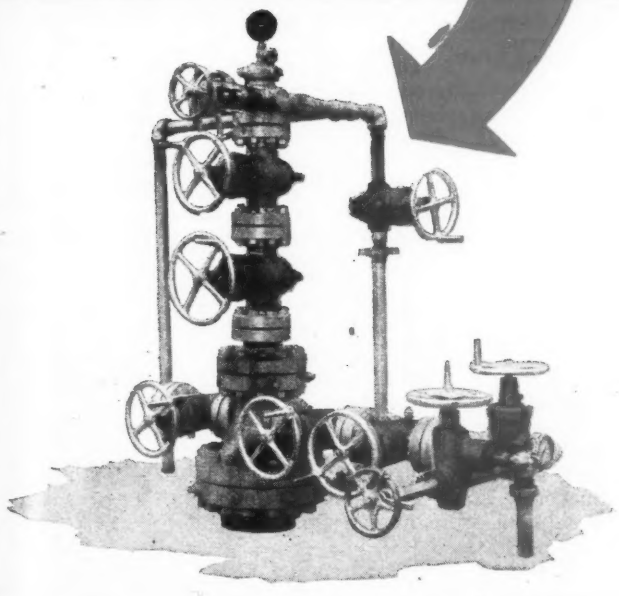

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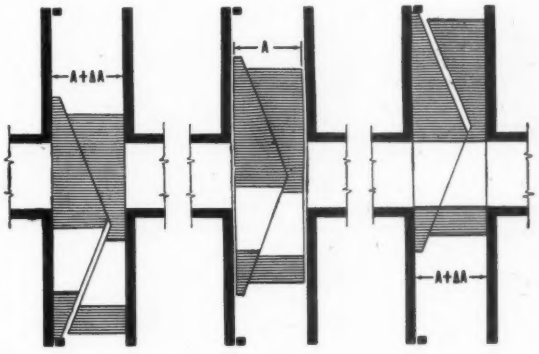

In closed position, the gate (left) and segment (right) seal tightly against both seats.

When opening or closing, the gate and segment are in neutral position, permitting free upward or downward movement of the gate assembly.

When open, the gate and segment again seal tightly against both seats and the bore of each lines up perfectly to provide a smooth, turbulence-free passage.

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Development of an API Thread Compound†

The problem of joint leakage in casing and tubing is of growing importance and research studies the best method of prevention

M. G. MAYBERRY*

Abstract

Compositions of inert fillers suitable for use both as lubricants and as sealants of threaded joints on oil-country tubular goods have been investigated. Tubing joints were made up with various products and pressure tested (to 10,000 psi hydrostatic pressure) to study the effect of composition upon the properties of thread compounds.

Test results prove that certain mixtures of lead, zinc, copper, and graphite dispersed in a suitable vehicle are satisfactory for this application. This thread compound forms a lead-resistant seal in the standardized 8-pitch, round-thread tubing joint. Field tests indicate that the vibration to which mill-end joints are subjected during shipment from the mill to the field has little effect upon the joint seal formed by this composition.

THE advent of deeper drilling has resulted in higher service pressures, increased formation temperatures, and heavier string loads. As a result, the problem of joint leakage in casing and tubing is of major importance. Field results have proved conclusively that threaded joints on oil-country tubular goods will not be pressure tight unless the threads are properly coated with a suitable thread compound. Most of the commercially available products consist of metallic zinc dispersed in a grease composition. These products have not been found suitable for deep high-pressure wells because they do not provide the necessary joint tightness.

At the 1947 meeting, the Special Research Subcommittee of the API Committee on Standardization of Oil-County Tubular Goods, recommended that the American Petroleum Institute sponsor an investigation for the purpose of developing a satisfactory thread compound. The requirements for such a compound as outlined in the report of that meeting follow:

a. Must have adequate lubricating qualities to prevent galling in the threaded connection during make-up.

b. Must not disintegrate nor undergo radical changes in volume at temperatures up to and including 300 F.

c. Must not become too fluid at temperatures up to and including 300 F.

d. Must have sufficient sealing action to be leak proof at a temperature of 300 F.

e. Must be stable and contain no frier or hardener to evaporate or oxidize and thus change the characteristics.

f. Must not readily absorb water.

g. Must contain an inert filler adequate to prevent leakage in API round-thread casing and tubing joints.

h. Should be readily applicable with a brush in cold weather.

The recommendation was approved, and a fellowship was established at Mellon Institute May 1, 1949.

General Summary

A pipe-thread compound consists of three components, viz: a sealant capable of forming a pressure-tight joint; a thread lubricant to insure adequate joint make-up at a reasonable torque and to prevent galling or chaffing of threads; and a vehicle or carrier to hold these components in suspension and aid in their application to the thread surfaces. In practice, it may be difficult to distinguish between the material acting as the sealant and that providing the thread lubrication. Various products commonly incorporated in commercial thread compounds appear to function in both capacities. For the present, however, these will be considered as separate components as thread lubrication and joint sealing are two distinct requirements.

Information regarding the relative effectiveness of various compounds used in most thread compounds is limited. H. J. Beckert and W. M. Frame of Spang-Chalfant Division of The National Supply Company showed the superiority of graphite grease as compared with zinc grease in a paper "Development of a New Thread Lubricant" presented at the 10th Mid-year Meeting of the American Petroleum Institute May 29, 1940. H. C. Zweifel ("Development of Thread Sealing Compound" presented at the 18th annual meeting of the National Lubricating Grease Institute) described the function of certain mixtures of lead, copper, and graphite.

Screening tests of certain typical commercial products were conducted to obtain additional information concerning the effect of composition upon certain properties.

Samples of commercial thread components presently being used in API coupled joints were obtained from oil companies and pipe mills for this purpose. These products were studied to determine the effect of exposure to air; their lubricating properties as measured by the number of turns joint make-up at a given torque; and the effect of time and temperature upon the seal formed in coupled joints.

Although these products were not tested exhaustively, certain conclusions may be drawn from the observed results. Thread components consisting essentially of a dispersion of powdered zinc in grease generally do not provide either adequate thread lubrication or a permanent, leak resistant seal. The particles of zinc appear to collect only in isolated sections of the engaged thread area of coupled joints rather than forming a continuous mass throughout. The addition of graphite to the dispersion of zinc in a grease improved the lubricating properties of the thread compound. In most instances, however, this component did not alter the sealing characteristics. Examination of thread sections of joints made up with such thread compounds indicated that distribution of filler was not uniform throughout the engaged thread area. This failure of metallic zinc to form a continuous, uniform mass in the engaged thread area provides a reasonable explanation of joint leakage in high pressure wells.

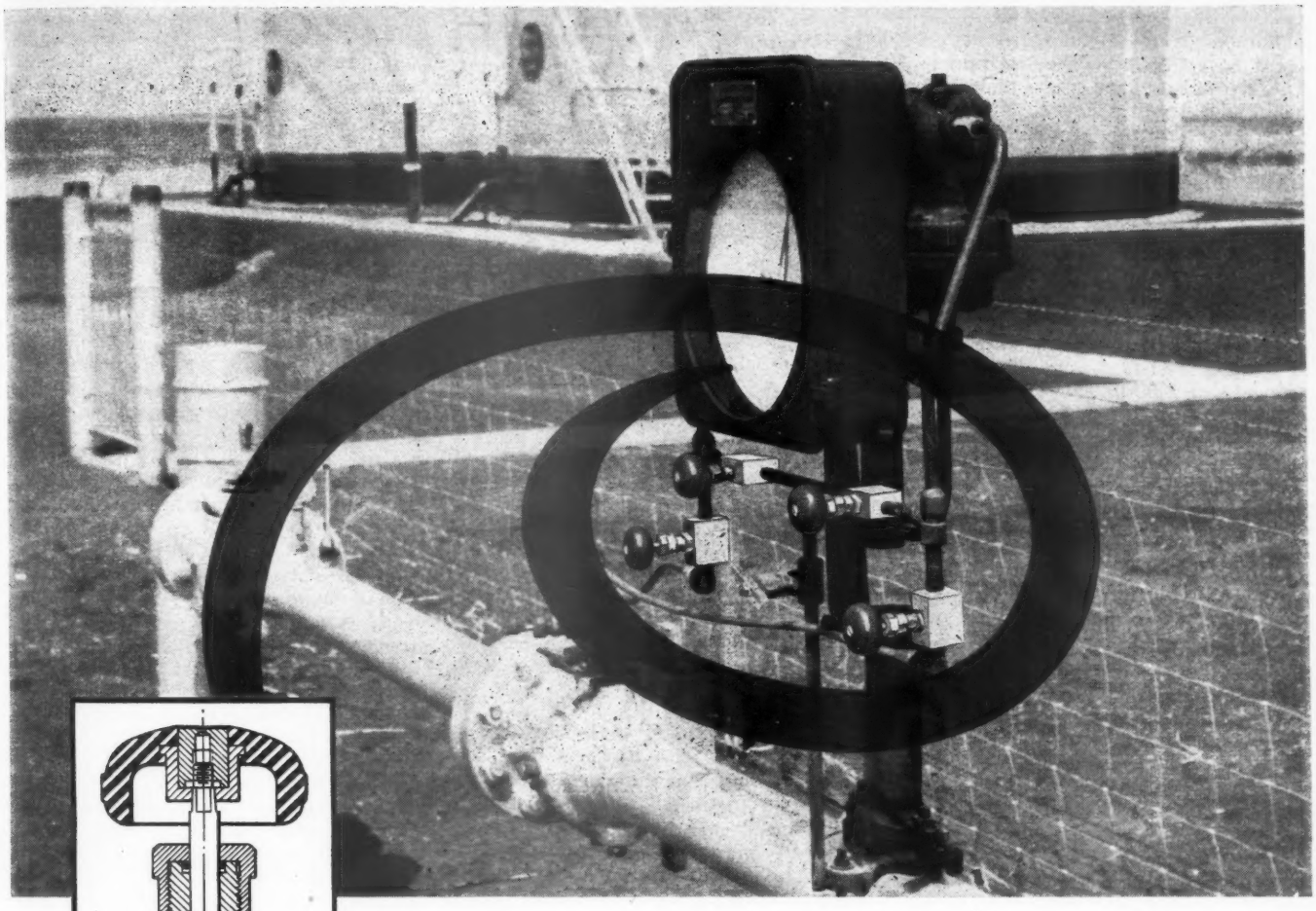
These tests further indicate that the grease phase has little value as a thread lubricant. It functions primarily as a dispersing medium or carrier for the filler composition. As such, it must hold the fillers in stable suspension; have only a limited change in consistency with changing temperature in order that the thread compound may be applied with a brush at temperatures ranging from 0 to 120 F; have some adhesion for metal in order to prevent the compound from being wiped off the threads during joint make-up; prevent corrosion of the thread area during storage.

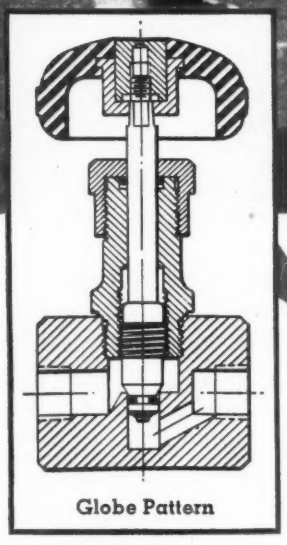
Certain mixtures of Silicone Fluid XF-60 and naphthenic base oils bodied with an aerogel-type silica and aluminum stearate were found to meet these requirements. Products having good adhesion for metal, resistance to moisture penetration, and only a slight change in consistency with changing temperature were prepared.

Petroleum base grease compositions containing 2.5 to 3 per cent lithium or

†Presented to a Division of Production group session during the 31st annual meeting of the American Petroleum Institute, Chicago, Illinois. November 6, 1951.

*Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania.





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aluminum stearates or mixtures of these soaps have also been used as vehicles. These products have less adhesion for metal and less resistance to moisture penetration, but they are much less expensive and form a stable product.

The optimum composition of inorganic fillers were found to consist of certain mixtures of lead, zinc, and copper powders together with graphite. The lubricating properties of thread compounds of such composition are comparable with the best commercially available products and all test joints were found to be leak resistant under hydrostatic pressures of 9000-10,000 psi. Test joints made up with these compounds were broken out without any damage to the threads.

Coupled joints made up with experimental thread compounds were pressure tested a minimum of 65 days using kerosine as the hydraulic fluid. Results of tests made in this laboratory and of similar tests conducted for the Humble Oil and Refining Company showed that joint tightness was a function of time. As none of the test joints developed leakage after 65 days, the test period used appears adequate.

Test joints known to be pressure tight were rolled and tumbled to simulate the vibration to which mill end joints are subjected during shipment. Subsequent hydrostatic pressure tests showed that vibration had no effect upon the seal. Field tests appear to confirm these results. After shipment from the mill to the field, only one mill end joint sealed with the experimental thread compound leaked when pressure tested. A larger number of joints sealed with commercial thread compounds leaked under duplicate conditions.

Test results presently available indicate that the experimental thread compound provides adequate thread lubrication for joint make-up and is capable of forming a leak-resistant seal.

Experimental Results Properties of Commercial Thread Compounds

A. **Lubricating Properties.** Coupled joints were made up with the various commercial thread compounds in order to determine the relative lubricating properties of these products. Pieces of 2-in. N-80 grade external upset tubing threaded with the API 8-round thread and corresponding couplings were obtained for this purpose. A plug approximately 1 in. thick, which had been drilled and tapped for a ¼ in. standard taper pipe thread, was welded in the plain end of each piece of tubing.

All thread sections were washed and cleaned and the thread dimensions measured. Threads of all joint members were found to be within API specifications. The given thread compound to be tested was applied to two pieces of tubing and a coupling and the joint assembled loosely. Each joint was placed in a torsion machine and made up to a measured torque of 50 ft-lb, the coupling being permitted to move freely. This was taken as the hand-tight reference position and the standoff was measured. Power make-up was then continued to a measured torque of 1200 ft-lb. Certain joints that made up less than one turn under these conditions were made up to a higher torque in order to obtain a minimum of one turn make-up at both ends of the coupling.

TABLE 1. Joint make-up with commercial thread compounds.

Joint No.	Thread compound, Code letter	Threads, hand-tight standoff A	Threads, hand-tight standoff B	Turns make-up 1200 ft-lb torque A	Turns make-up 1200 ft-lb torque B
6	A	1.5	1.5	1.25	1.5
8A	B	1.5	1.5	0.9	1.1
8A	C	2	2	2	2
10	D	2.5	2	0.75	1
11	E	1.5	2	1.25	1.25
12	F	2.5	1.5	1.1	1.1
14	G	3	2	1.5	1.5
16	H	2	2.5	2	2.2
17	J	2	3	0.9	1
18	K	2	2	2	3
19	L	2	1	1.75	1.5
20	M	3	2	1.6	1.6
22	N	2	3	1	1
25	O	1.5	1	1.1	1.1
26	P	1	1.5	1.9	1.9
27	Q	1	2	1.25	1.5
30	R	2	3	0.9*	1
34	S	2	1.5	1.3	1.3
36	T	1.5	1.5	1.4	1.5
37	U	1	2	1.4	1.1
38	V	1.25	1.25	1.6	1.4
39	W	2.5	2	0.8**	1.25

*Joint made up 1 full turn at 1770 ft-lb torque.
** Joint made up 1 full turn at 2225 ft-lb torque.

The results are given in Table 1. As these tests were not designed to measure the relative merits of commercial thread compounds, the products are designated by code letter only.

B. **Hydrostatic Pressure Tests.** The coupled joints were connected to a hydraulic pump and pressure gage by means of pressure fittings and filled with kerosine. A pressure of 5000 psi was applied and held for a period of one hour. The pressure was increased periodically in increments of 1000 psi until a minimum pressure of 9000 psi was obtained. Joints that did not leak were held under pressure at least 16 hours. Test results are given in Table 2.

The test joints were drained and those that proved to be pressure tight were stored in a constant temperature room at 70 F for 60 days. These joints were again pressure tested following the procedure described above. No leakage resulted from storage.

After draining the kerosine, the test joints were placed in an oven heated to 365-375 F for a period of three weeks. Each section was allowed to cool to room temperature and was again pressure tested. The results are included in Table 2.

C. **Effect of Storage in Air.** The effect of continuous contact with air upon the properties of commercial thread compounds was studied. Steel cups, 1 in. square and ½ in. deep with sharp corners and square edges, were made for this purpose.

The sample to be tested was placed in a cup and worked to remove all air. The surface was then leveled off flush with the top of the cup to insure the exact volume. After standing in contact with air at room temperature for a period of one to two weeks, the compounds were examined for possible change in volume or surface characteristics.

Little or no change in the volume or properties of most samples was detected. Products identified by the code letters S and X showed a decrease of more than 10 per cent in volume. This change resulting from the evaporation of a volatile component also produced a change in consistency. A tough film or skin formed on the surface of products bearing the code letters P and W, although no appreciable change in volume occurred.

Experimental Thread Compounds

Composition of Vehicles. Certain liquids having a relatively low vapor pressure at 350-375 F, a relatively flat viscosity-temperature curve, and little tendency toward air oxidation were selected for investigation as the base for a thread-compound vehicle. Ucon Lubricant LB-300Y, Flexol Plasticizer TWS and Silicone Fluid XF-60 were used. Various aluminum stearates and Bentones were mixed with these compounds in an effort to obtain a composition having the desired properties. Such com-

TABLE 2. Hydrostatic pressure tests of coupled joints made up with commercial thread compounds.

Joint No.	Thread compound, code letter	Test pressure, psi	Test period, hours: initial	Test period, hours: after aging	Test period, hours: after heating	Results
6	A	7800–10200	16	19	90	No leak
8A	B	7000	15	—	—	End B leaked
8B	C	8200–10300	17	17	41	No leak
10	D	9000–10200	16	64	16	No leak
11	E	9000–10250	16	19	48	Both ends leaked*
12	F	9000–10200	63	137	16	No leak
14	G	9000–10175	16	19	18	No leak
16	H	9000–10100	16	18	40	No leak
17	J	9000–10400	64	17	42	No leak
18	K	9000–10300	21	89	17	No leak
19	L	9000–10200	18	18	18	No leak
20	M	9000–10200	16	18	18	No leak
22	N	9000–10175	15.5	18	19	No leak
25	O	9000–10100	19	17	2.5	End A leaked*
26	P	9000–10200	17	17	67	No leak
27	Q	9000–10200	17	90	98	No leak
30	R	9000–10150	264	67	21	No leak
34	S	9400–10000	0.5	—	—	End A leaked
36	T	9000–10100	15.5	—	—	End B leaked
37	U	9000–10200	21	17	17	No leak
38	V	9000–10200	18	19	18	No leak
39	W	9000–10100	18	19	40	No leak
40	X	9000–10100	61	61	113	No leak

* Joint leaked after heating.

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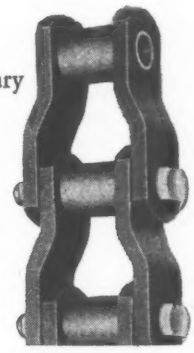

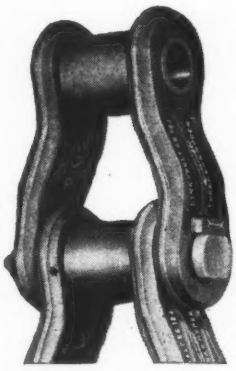

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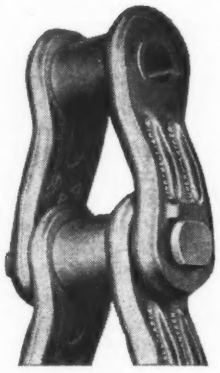

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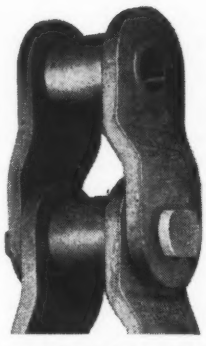

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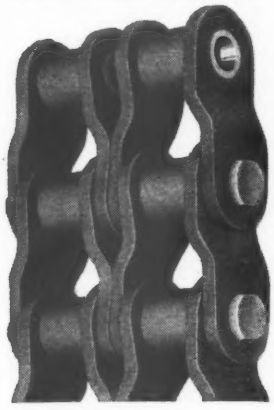

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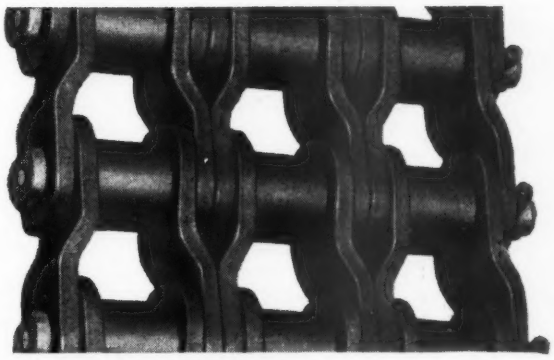

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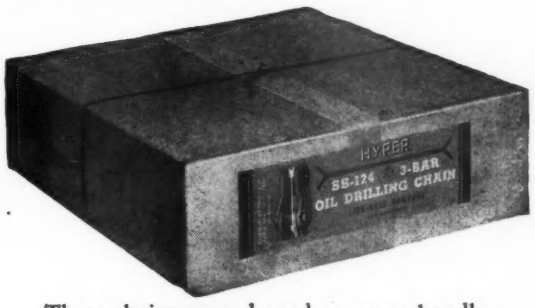

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positions lacked stability and most of the liquid separated on storage.

Grease compositions having good adhesion for metal, were prepared by incorporating certain type of silica in Silicone fluid XF-60. An aerogel type silica (for example, Santocel-C prepared by Monsanto Chemical Company) or a similar product having a high pore volume and high oil absorption is required. Mixtures of 7 to 10 per cent silica and 90 to 93 per cent Silicone fluid XF-60 were slurried at room temperature and then worked on a 3-roll mill until a smooth, stable grease of uniform composition was obtained.

Although the Silicone grease adhered to metal, it was not completely resistant to penetration by moisture or water vapor. Mixtures of Silicone fluid and certain petroleum oils were investigated for the purpose of improving this property. Naphthenic base oils having a Saybolt viscosity of 200 seconds or less at 100 F and an Aniline point of less than 197 were found to be completely miscible with Silicone fluid XF-60. Grease compositions, showing only a slight tendency to bleed during storage below 200 F, were obtained by bodying mixtures of naphthenic base oil (vis at 100 F, 200 S. S. U.) and Silicone fluid XF-60 with aluminum stearate and powdered silica.

The grease was prepared by heating a mixture containing 6.15 per cent Witco No. 18 Aluminum Stearate dispersed in the naphthenic base oil to 260 F with continuous stirring until completely gelled. This gel was cooled without stirring, to 75-80 F as quickly as possible (3-4 hours) and then worked to a smooth grease. To 426.7 g. (56.9 per cent) of this grease was added 276.3 g. (36.84 per cent) of Silicone compound, containing 5.7 per cent silica dispersed in Silicone fluid XF-60, and 46.9 g. (6.26 per cent) of Silicone fluid XF-60. This mixture was stirred together at room temperature and then worked on a 3-roll mill. A soft, smooth grease of uniform composition was obtained.

This grease has a worked penetration of 350 at 77 F and 382 at 32 F.

Resistance to Moisture Penetration. A film of the above grease less than 0.003 in. in thickness was prepared on a clean steel plate. Glass tubes 1 in. in diameter and open at both ends were cemented to the film using the same product. Approximately 3 cc. of salt solution containing potassium ferricyanide was placed in each tube and the time required for the solution to penetrate the grease film determined. No evidence of film failure was detected at the end of two weeks.

The product was exposed in a humidity cabinet in order to compare test results. For this purpose, steel coupons 3 in. by 5 in. were sanded bright and then washed with benzene. Duplicates were coated with films of the grease approximately 0.01 in. thick. These coupons were placed in a cabinet having a relative humidity of 95-100 per cent at 122-125 F (50-52 C) for a period of two weeks. The coupons were hung in such a position that moisture condensed on the surface of the grease film. No evidence of corrosion of the coated portion of the coupons was noted at the end of the test period.

Petroleum grease compositions prepared with the Bentones and certain lithium and aluminum stearates were also investigated for use as vehicles in thread compounds. Bentone greases have many desirable properties, including adhesion for metal and temperature stability. Products having sufficient body to hold the fillers in stable suspension, however, do not flow readily under pressure.

Greases containing 2.5 to 3 per cent lithium stearate (Warwick's No. 2 or Foote's Litholite A), Witco No. 18 Aluminum Stearate or a mixture of these soaps appear satisfactory for use as a vehicle. Products having this composition were prepared in the laboratory and found to have adequate body and satisfactory flow characteristics.

Composition of Thread Compounds. A satisfactory thread compound must provide adequate thread lubrication for joint make-up and must form a permanent pressure-tight seal. Preliminary tests showed that grease compositions do not provide sufficient thread lubrication to prevent galling. Therefore, an active lubricant must be incorporated in the grease compositions. Graphite and molybdenum sulfide were investigated for this purpose.

TABLE 3. Composition of experimental thread compounds composition, per cent by weight.

Exp. No.	Grease base	Lead	Zinc	Aluminum	Copper	Molybdenum sulfide	Graphite
54-1	40.2	17.9[1]	—	—	38.7	3.2	—
54-2	39.8	28.3[2]	—	—	28.3	3.6	—
54-3	38.9	27.6[2]	—	—	27.6	—	5.8
72-1a	55.7	9.7[2]	—	15.9	14.8	3.9	—
81A	45.5	15[2]	—	5	30	4.5	—
85-1a	50	15[2]	—	5	30	—	—
87-3a	31.8	46.7[2]	—	1.8	14.7	2.7	2
111-1	29.7	45.0[2]	13.8	1.5	—	—	10
111-3	34	28[3]	26.5	1.5	—	—	10
118-1	37.8	25[3]	15.7	1.5	—	—	20
118-2	37.3	27[3]	15.7	—	2.0	—	18
131-1	34.8	34.4[3]	10.8	—	2	—	18
138-1	36	31[3]	13	—	2	—	18
143-2	36	31	13	—	2	—	18
161	35.6	30.7[2]	12.9	—	3	—	18

[1] Superfine "S" lead powder (Metalead Products Corporation, San Francisco)
[2] Standard lead powder (Metalead Products Corporation)
[3] Graded lead powder (Metalead Products Corporation)
MD-107 lead powder (Metal Disintegrating Company, Elizabeth, New Jersey

The sealing agent for API coupled joints must be capable of forming a compact, impermeable mass in the capillary existing between the root and crest of mating threads. As it is frequently necessary to break the joints, this agent must not form a permanent bond between the joint members. Further, the seal formation must be independent of the temperature of the application and of the rate of the joint make-up.

Soft malleable metals, such as lead, copper, and aluminum which are readily deformed under pressure, were selected for the preliminary investigation. Certain mixtures of these metals and a lubricant (graphite or molybdenum sulfide) were dispersed in a silicone-base vehicle. The compositions of representative products prepared are given in Table 3. Coupled joints were made up and pressure tested, in the laboratory to determine the properties of the experimental thread compounds. These tests are described, in detail, in later sections of this paper.

The results of the tests showed that the mixtures of copper and lead investigated did not form a permanent leak resistant seal, and that the presence of aluminum powder caused an increase in make-up torque requirements.

The test results indicated, also, that certain mixtures of lead, copper, and graphite dispersed in the Silicone-base vehicle formed a seal in the API coupled joint during make-up. The lead resistance of the joint varied with time, however, and the seal was not resistant to vibration. As most of the engaged threads of the joints made up with such formulations were found to be coated with a thin film of metal, it is believed that the mass moved under the combined forces exerted by hydrostatic pressure and by the joint stresses developed during make-up. Therefore, a small amount of material, susceptible to deformation under the pressure of joint make-up but resistant to plastic flow, should provide a permanent leak-resistant seal.

Previous experiments with conventional thread compounds indicated that metallic zinc might prove satisfactory. Although it does not form a continuous film or coating on the surface of the engaged threads when used alone, particles of metallic zinc were pressed out in the thread capillary.

Samples of thread compounds containing lead, zinc, copper and graphite dispersed in the silicone-base vehicle were prepared for investigation. Compositions of representative products are given in Table 3. The inclusion of metallic zinc in the thread compound formula was found to improve the sealing properties.

The cost of the silicone-base vehicle used in the experimental thread compound may limit the application of this product to high pressure installations. As has been noted, the primary objective of this investigation was the formulation of a product suitable for use in deep high-pressure wells. An inexpensive thread compound suitable for gen-

TABLE 4. Composition of experimental thread compounds.

Exp. No.	Vehicle composition, per cent metallic soap	Composition of thread compounds per cent by weight: Vehicle	Lead	Zinc	Copper	Graphite
193A-1	4.5 Lithium Stearate[1]	36	29.8	12.2	4	18
193B-1	4.0 Lithium Stearate[1]	36	29.8	12.2	4	18
202-2	5.1 Lithium Stearate[1] 0.75 Aluminum Stearate[3]	36	28	12	4	20
202-3	5.4 Lithium Stearate[1] 0.5 Aluminum Stearate[3]	36	28	12	4	20
216-2	2.4 Lithium Stearate[1]	35.7	32.1	10.3	3.95	17.95
220A	1.95 Lithium Stearate[1] 0.55 Aluminum Stearate[3]	36	31.9	10.1	4	18
227-1	2.45 Lithium Stearate[1]	36	31.8	10.2	4	18
227-2	2.5 Aluminum Stearate[2]	36	31.8	10.2	4	18
230-3	1.25 Lithium Stearate[1] 1.25 Aluminum Stearate[3]	32.6	33.7	10.7	4.2	18.8

[1] Litholite A, Foote Chemical Company.
[2] Lithium Stearate No. 2, Warwick Chemical Company.
[3] Aluminum Stearate No. 18, Witco Chemical Company.

TABLE 5. Screen analyses of powdered metals.

Screen size	Per cent composition: powdered lead products: Superfine "S"	Standard	Graded	MD-107	powdered zinc: Sample No. 1	Sample No. 2
On 48	0	0.1	2	—	1.4	0
On 100	0	3.3	—	1.7	9.8	0.4
On 200	0	11.6	18	35.9	—	—
On 230	0	—	—	—	20.2	14.9
On 325	0	12.0	8	24.1	9.2	9.8
Thru 325	100	73.0	72	38.3	59.4	74.9

eral application is desirable, however. For this reason, petroleum base grease compositions are being investigated as possible replacements for the silicone base vehicle.

Compositions prepared with Bentones, lithium stearates, and aluminum stearates as bodying agents have been studied. Preliminary tests indicated that Bentone greases are not satisfactory for this application. Coupled joints made up with thread compounds containing a Bentone grease vehicle were not pressure tight. Examination of thread sections after breaking out representative test joints showed that the filler dispersed in the vehicle did not form a compact mass in the thread capillary during joint make-up.

Thread compounds have been formulated wtih certain lithium and aluminum stearate greases as the vehicle. Approximately the same composition of inert fillers used in the silicone base thread compounds were dispersed in the petroleum-base vehicles. The compositions of the vehicles and of the various thread compounds prepared are given in Table 4.

Preliminary tests indicate that grease compositions containing 2.5 to 3 per cent soap may prove satisfactory. Such compositions have sufficient body to hold the solid fillers in suspension, yet are susceptible to flow under pressure.

Particle Size and Description of Fillers. Powdered metals of varying particle size and shape were obtained for use in the preparation of experimental thread compounds. Conventional grades of lead powder of varying particle size were examined. The screen analyses of these products are given in Table 5. Two samples of powdered zinc were obtained. The screen analyses of these samples are included in Table 5. The variations in particle size of the powdered zinc did not appear to affect the properties of the thread compounds.

Copper was found to function primarily as a thread lubricant. As such, it was used in flake form rather than pellets or spheres. This product, No. Triple 7, was obtained from the Magna Manufacturing Company, New York, New York. The same grade of aluminum flake obtained from the same source was used.

Columbian Plumbago grade graphite manufactured by the United States Graphite Company was found to be most effective for use with the combination of fillers.

Joint Make-up. Coupled joints were made up with the experimental thread compounds in order to study the lubricating and sealing qualities of these products. Pieces of N-80 grade, 2-in. external-upset tubing, threaded with the 8-round API thread, and corresponding couplings were used. One-inch plugs, drilled and tapped for a ¼-in. standard taper pipe thread, were welded in the plain end of each piece of tubing.

All threads were washed and brushed to remove any residual grease or dirt and the thread dimensions determined. The thread compound to be tested was applied to the threads of each of two pieces of tubing and the joint assembled. Each joint was placed in a torsion machine and made up to a measured torque of 50 ft-lb. This was taken as the reference hand-tight position and the stand-off measured. Power make-up was continued at a constant rate of ½ rpm, the maximum speed of the torsion machine used. All couplings were pulled

TABLE 6. Make-up of coupled joints, silicone-base thread compounds.

Joint no.	Thread compound no.	Joint members: A Tube no.	A Coupling no.	B Tube no.	Threads handtight standoff: A	B	Turns power make-up: At 1200 ft-lb torque: A	B	At maximum torque: A	B	Maximum torque used, ft-lb	Approx. joint temp., deg F
55	54–1	2S	S3–4	3S	1	2	1.1	1.6	1.6	2.4	1867	130
78	54–1	16S	S17–18	17S	2.5	2.5	1.5	1.25	2.5	2.25	3059	130
105	54–1	8J	J8–7	17J	2	2	0.75	0.9	2.6	1.9	2908	145
56	54–2	4S	S5–6	5S	2.5	2.5	1.3	1.5	2.2	2.6	2717	120
57	54–3	6S	S7–8	7S	2	2	1.2	1.4	1.8	2.4	2467	115
75	72–1a	12S	S13–14	13S	2.25	1.9	1	0.9	2.5	1.75	2800	145
83	81A	19S	S19–20	18S	2.5	2	1.3	1.1	2.9	1.9	2450	143
89	85–1a	4J	J13–14	7J	2.5	1.75	1	1.4	2.5	2.75	2458	145
94	87–3a	3J	J5–6	11J	2	2.25	1.7	1.7	3.2	2.3	1710	130
112	111–1	15S*	S9–10*	17S*	1.25	1.5	1.7	1.5	2.25	2.0	1800	120
114	111–3	9J*	Y8–7*	20J*	0.5	1.25	1.8	1.6	2	2	1971	135
119	118–1	4S*	J15–16*	11Y*	1.4	2	1.1	1.5	1.6	2.6	1792	140
120	118–2	16S*	S15–16*	12Y*	1	2.3	1.75	2	2	3.7	1538	130
121	118–2	7Y*	S21–22	10Y*	2.5	2.3	1.95	2.15	2.6	2.9	1604	140
133	131–1	8Y*	S27–28	9Y*	2	2.5	1.9	2	2.25	2.85	1338	135
139	138–1	1NT	NT1–2	3NT	1.25	2	1.9	2	2.4	2.6	1525	125
145	138–1	4NT	NT3–4	5NT	1.3	1.5	1.5	1.9	2.2	2.4	1633	125
151	138–1	8NT	NT7–8	9NT	1	1.1	1.5	1.9	2	2.5	1525	110
153B	138–1	16NT	NT15–16	17NT	1.4	1.4	1.6	1.7	2.2	2.4	1775	135
146	143–2	6NT	NT5–6	7NT	1.8	1.5	1.75	1.75	2.3	2.25	1560	120

* Joint members had been used previously in making up on test joint.

TABLE 7. Make-up of coupled joints, petroleum-base thread compounds.

Joint no.	Thread compound no.	Joint members: A Tube no.	A Coupling no.	B Tube no.	Threads handtight standoff: A	B	Turns power make-up: At 1200 ft-lb torque: A	B	At maximum torque: A	B	Maximum torque used, ft-lb	Approx. joint temp., deg F
194	193A–1	13NT*	S34 –33	11P*	1.5	2.25	1.6	1.8	1.9	2.5	1541	125
196–1	193B–1	8NT*	NT19–20	12P*	1	1	1.4	1.4	2	2	1554	125
203	202–2	1P*	NT3–4*	23P*	0.5	0.6	1.5	1.6	2	2	1575	110
204	202–3	16NT*	NT5–6*	17NT*	0.5	0.6	1.4	1.2	2.5	2	1950	120
216–2	216–2	14P*	J & L**	4P*	2	2.25	1.75	1.8	2.25	2.25	1558	115
218–2	216–2	11P*	J & L**	22P*	2.25	2.5	2.25	2.25	2.55	2.5	1442	110
221	220A	5P*	J25–26	6P*	2.25	2.5	2	2.45	2.3	2.7	1375	130
231	227–1	1S	S1–2	2S	1	1.5	1.6	1.4	2.1	2.3	1667	135
232A	227–2	3S	S3–4	4S	1.5	1.8	1.25	1.5	2	2.7	1725	140
232B	227–2	5S	S11–12	6S	2	1.5	1.1	1.9	2.25	2.4	1900	140
233	230–3	7S	S5–6	8S	1	1	1.6	1.6	2.25	2.5	1694	140

* Joint members used previously in making up test joints.

TABLE 8. Strength of coupled joints.

Joint no.	Thread exposed handtight D.E.	Thread exposed handtight W.E.	Make-up torque load in-lb D.E.	Make-up torque load in-lb W.E.	Pull-out, tons plain-end	Pull-out, tons joint	Joint efficiency per cent
Experimental thread compound (Product No. 161)							
1AZ	2½	2½	51,000	51,000	250	165	66.0
2AZ[1,2]	2½	3	52,000	46,000	237	158	66.7
2BY	3¼	2½	35,700	41,100	237	153	64.6
3AZ	2½	3	44,100	44,100	236	151	64.0
4AZ	2½	3	51,300	52,300	240	157	65.4
4BY	2½	2	46,400	42,400	240	155	64.6
Average			46,750	46,417			65.2
Standard zinc-base lubricant							
1BY	4	2½	60,200	47,600	250	164	65.6
1CX	2	3½	75,600	60,000	250	168	67.2
2CX[1]	2½	3½	48,700	39,000	237	152	64.1
3BY[2]	3	1½	43,000	57,700	236	155	65.7
3CX[2]	2½	3½	83,200	62,200	236	157	66.5
4CX	1½	2½	63,200	52,000	240	157	65.4
Average			62,317	53,083			65.8

[1] Thread compound applies to pipe threads only.
[2] Joints pulled out on drive end (D.E.); all other joints pulled out on weight end (W.E.)

approximately ½ thread beyond the last scratch or to a minimum torque. Test results, showing the number of turns make-up and the torque required using silicone-base thread compounds, are given in Table 6. Results of make-up tests using the petroleum-base products are given in Table 7.

The replacement of silicone-base vehicle by a petroleum product did not have any appreciable effect upon the lubricating properties of the thread compounds.

Effect of Rate of Make-up Upon Torque. Mill end joints were made up with the API thread compound at the Jones and Laughlin Steel Corporation to determine the torque required for make-up. "These tests were made on 2⅜-in. OD J-55 threaded and coupled upset tubing taken from a regular run of production. The threads were cleaned before applying the grease and the couplings were pulled up hand tight with a standoff between 2 and 2½ threads. The couplings were then pulled up machine tight to the last scratch and the torque measured." These joints were made up at a speed of 27 rpm.

Similar tests were made at the same time using certain commercial thread lubricants. The results of the test are shown below.

Mill end joint make-up at 27 rpm

No. test joints	Thread lubricant	Torque required, ft-lb Minimum	Maximum	Average
48	Exp. API	650	1840	1213
51	"A1"	650	2600	1485
32	"B1"	760	1950	1405

Coupled joints were also made up at 27 rpm allowing the coupling to move freely between two nipples. The nipples, 1-ft pieces of 2-in. No. 80 grade threaded and coupled upset tubing, were obtained by breaking out test joints that had failed when subjected to hydrostatic pressure of 9000 to 10,000 psi in the laboratory. With the exception of the one used on joint 228B-1, new couplings taken from stock were used. The coupling used on joint 228B-1 had been machined to remove the first scratch and a portion of the bevel at the coupling recess.

All joint members were washed and brushed to remove the residual thread compound, grease, or dirt present in the thread sections. The thread compound to be tested was applied to the tubing threads and the joint made up hand tight. The joints were then made up machine tight to the last scratch and the torque measured.

The results of these tests are shown below.

Complete joint make-up at 27 rpm

Joint No.	Thread compound no.	Hand tight standoff threads A	Hand tight standoff threads B	Torque required ft-lb
228A-1	Exp. API	2½	2½	1517
228A-2	Exp. API	2½	2½	1733
228B-1	227-1	3	2½	975
228B-2	227-1	2½	2½	1408
228C-1	227-2	3	2½	1517
228C-2	227-2	3	2	1192

Pull-Out Strength of Coupled Joints. The average torque required to make up coupled joints with a thread compound having a composition similar to that of product 118-2 was lower than the torque required for the same amount of make up in the presence of most conventional zinc-base compounds. The question of the effect of this improved thread lubrication upon the pull-out strength of coupled joints was raised.

Tests to determine the comparative pull-out strength of joints made up with the API thread compound and with a conventional zinc-base product were made by the National Tube Company. The report of the testing procedure and the results obtained follows.

"Four lengths of 5½-in. OD by 0.304 wall, range 3, J-55 casing were selected from a current rolling and sectioned so as to obtain three 10-ft joints and one 10-ft plain-end test from each length, or a total of 12 joints. Six joints were made up using the standard zinc grease and six using the experimental grease. Thread measurements were taken on both the couplings and pipe previous to make up and all measurements were within tolerance. Both joints were made up three turns from the hand-tight position, except joint 1BY. This joint could be made up only 2¼ turns on the weight end, due, probably, to a slightly larger taper of the pipe threads on that end.

Make up and pulling loads, as well as joint efficiencies, are listed in Table 8.

The results show thaf the lubricating properties of the experimental thread compound, as measured by the torque required for joint make up, are superior to those of the standard zinc-base lubricant. A more uniform rate of make up at both ends of the coupling was also observed in the presence of the experimental thread compound. The slight variation in joint efficiency, however, indicates that the experimental thread compound does not affect joint strength.

Hydrostatic Pressure Tests of Coupled Joints. The coupled joints made up with various experimental thread compounds were pressure tested at 9000-10,000 psi, in order to determine the sealing properties of these products. Kerosine was selected for use as the hydrostatic fluid because of its solvent properties and ease of handling.

Test joints were filled with kerosine and connected in series, by means of high pressure connectors, with a hydraulic pump and a pressure gage. Five joints were connected together in one such series and three joints in another. A pressure of 5000-5600 psi was first applied to each joint and held for a period of one hour. The pressure was then increased in increments of 1000-1500 psi until a minimum pressure of 9000 psi was obtained. The joints were held under pressure ranging from 9000 to 10,400 psi until leakage developed, or for a minimum period of 65 days.

The pressure on the joints was not maintained at 9000 psi or higher continuously during the test period. Since the pressure fittings connecting the joints in each series were not equipped with valves, the pressure on all joints connected in a series was released in order to replace a test joint which failed. Only the time during which the pressure was above 9000 psi, however, was considered in measuring the test period for each joint. Test results are given in Table 9.

The pressure tests showed the effect of the composition of the experimental thread compounds upon their sealing properties. Products consisting of mixtures of lead, copper and a lubricating agent (graphite or molybdenum sulfide) failed to form a permanent pressure tight seal. As has been noted, the leak-resistance of the seal varied with time.

Other thread compounds containing mixtures of lead, aluminum and copper, or lead, aluminum, and zinc together with a lubricant formed permanent lead-resistant seals in the test joints. However, the lubricating properties of such products, as indicated by the torque required for joint make-up proved to be unsatisfactory.

Mixtures of lead, zinc, copper and graphite dispersed in the silicone base vehicle formed the most satisfactory

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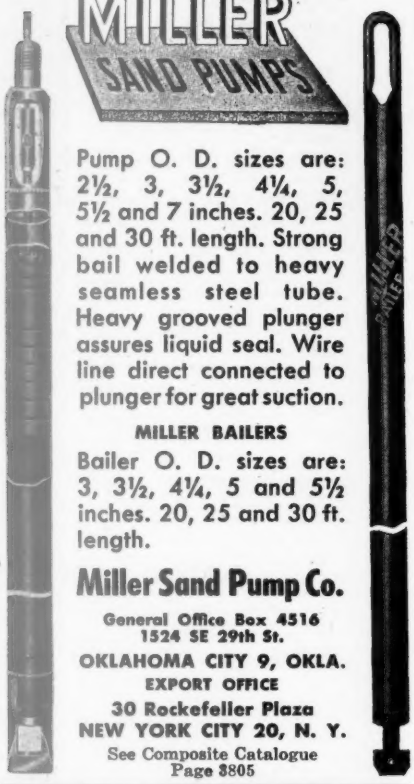

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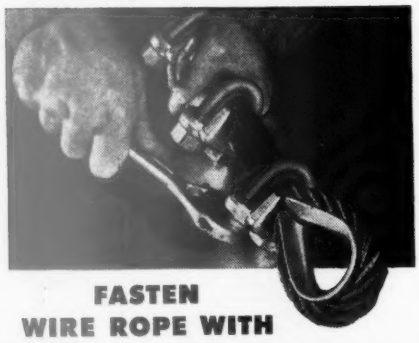

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TABLE 9. Hydrostatic pressure tests of coupled joints.

Joint no.	Thread compound no.	Test pressure, psi	Test period, days	No. times pressure released	Results
55	54–1	9000–10200	68	4	No leak; test stopped
78	54–1	8850–10000	1	0	Leak at end B
105	54–1	9000–10000	1	0	Leak at end B
56	54–2	9000–10400	37	1	Joint leaked at both ends
57	54–3	9100–10350	55	3	Joint leaked at both ends
75	72–1a	9100–10350	69	4	No leak; test stopped
83	81A	9000–10350	69	4	No leak; test stopped
89	85–1a	9100–10200	70	5	No leak; test stopped
94	87–3a	9000–10200	65	4	No leak; test stopped
112	111–1	9000–10100	71	2	No leak; test stopped
114	113–3	9000–10000	70	4	No leak; test stopped
119	118–1	9000– 9800	13	0	Leak at end A
120	118–2	9000–10400	77	2	No leak; test stopped
121	118–2	9000–10400	71	2	No leak; test stopped
133	131–1	9000–10350	68	2	No leak; test stopped
139	138–1	9000–10150	65	4	No leak; test stopped
145	138–1	9000–10150	76	5	No leak; test stopped
151	138–1	9000–10000	78	6	No leak; test stopped
153B	138–1	9000– 9950	76	6	No leak; test stopped
146	143–2	9000–10200	71	2	No leak; test stopped
194	193A–1	9000–10400	76	2	No leak; test stopped
196	193B–1	9000–10200	75	4	No leak; test stopped
203	202–2	9000–10200	105	5	No leak; test stopped
204	202–3	9000–10200	100	4	No leak; test stopped
217-B	216–2	9000–10200	70	2	No leak; test stopped
218–2	216–3	9000–10200	70	2	No leak; test stopped
221	220A	9000–10200	74	3	No leak; test stopped
228A–1	API	9200–10100	13	1	No leak
228B–1	227–1	9300–10100	2	0	Joint leaked
228B–2	227–1	9400–10200	14	0	No leak
228C–1	227–2	9300–10100	20	0	No leak
228C–2	217–2	9000– 9600	18	1	No leak
232A	227–1	9100– 9600	8	0	No leak
232B	227–1	9100– 9600	8	0	No leak
233	230–3	9200– 9800	8	0	No leak

TABLE 10. Effect of vibration and heat upon seal in coupled joints.

Joint no.	Thread compound no.	Vibration period, days	Heating period, days	Test pressure, psi	Test period, days	Results
55	54–1	11	—	9200–10000	4	Leak at end A
75	72–1a	11	—	9000–10000	69	No leak
83	81A	11	—	9000–10000	19	No leak
112	111–1	13	—	9600– 9800	9	No leak
120	118–2	13	21	9000– 9800	70	No leak
121	118–2	13	—	9000–10000	16	No leak
133	131–1	13	—	9200– 9700	27	No leak
139	138–1	—	21	9000– 9900	58	No leak
194	193A–1	7	—	9000–10200	23	No leak
196	193B–1	7	—	9000– 9500	10	Leak at end A
203	202–2	7	—	9000–10200	23	No leak
204	202–3	7	—	9000–10200	23	No leak

thread compounds. These products had adequate lubricating properties and formed a permanent leak-resistant seal.

The test results also indicate that thread compounds formulated with certain petroleum grease compositions as the vehicle may form a satisfactory leak-resistant seal. Coupled joints made up with these products have held hydrostatic pressure for the duration of the test period. These tests are not complete, however. These test joints were assembled with joint members that had been used previously. Although such joints provide an indication of the relative properties of various experimental products, the test results cannot be considered conclusive. In general, coupled joints made up with used joint members are sealed more readily than new pieces. These tests are being continued.

Effect of Vibration and High Temperature Upon Joint Tightness. Field experience has shown that a high percentage of the tubing joint leakage in high pressure wells results from the failure of mill end joints. Pressure tests of tubular goods, both at the mill and after arrival in the field, indicate that in many instances the mill end seal is broken during shipment. The vibration to which these joints are subjected during shipment appears to destroy the seal obtained with most of the conventional thread compounds.

The effect of vibration upon the seal formed by various experimental products was investigated. For this purpose, test joints known to be leak resistant were selected for study. Four test joints were placed in a piece of 8-in. pipe 28 in. in length. The ends of the container were closed to restrict movement of the joints in a direction parallel to the axis of the pipe. Thus the couplings of two or more joints were in continuous contact. The joints, however, were free to rotate as the container revolved. The container was placed on a set of continuous rolls and revolved continuously for a period of one to two weeks causing the test joints to roll over and tumble against each other at the couplings. All paint was worn from the surface of the couplings and the exposed metal polished by this action.

After vibration, the joints were again filled with kerosine and pressure tested at 9000-10,000 psi. Test results are given in Table 10.

The effect of high temperature upon the seal formed by experimental thread compounds was also determined. Joints known to be pressure tight were placed in an oven held at 365-375 F for a period of 3 weeks. The joints were heated at atmospheric pressure. At the end of the heating period, the joints were allowed to cool to room temperature, refilled with kerosine, and again pressure

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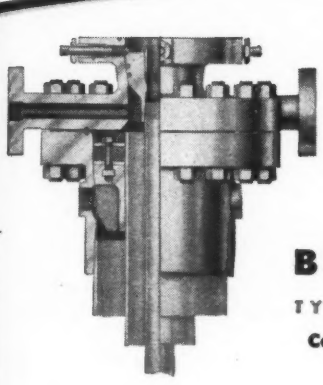

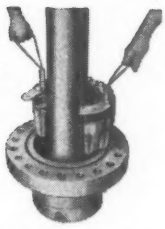

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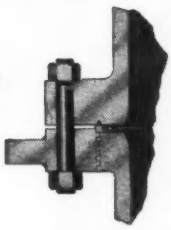
Type "UPS" Heads—a new Baash-Ross development—have the Packing Element and Slips unitized into a *single* hinged assembly that simply w-r-a-p-s around the casing and locks in place with one bolt. As the weight of the casing is placed on the slips, they *automatically* equalize themselves within the bowl to assure exact centering of the casing as well as a uniform grip around the *entire circumference* of the pipe. A few quick turns of a wrench then expands the packing element for a pressure-tight seal.

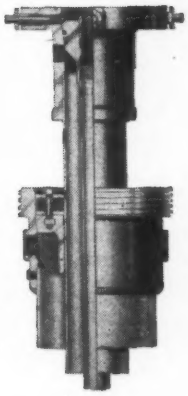
"UPS" ADVANTAGES INCLUDE . . . (1) No space wasted by threads, grooves or other packer-retaining devices—therefore overall height is reduced to a minimum . . . (2) Elimination of threads, grooves, etc., means a smooth bowl—nothing to become damaged during drilling operations, no need for protective sleeves . . . (3) Since all the slip segments are unitized together, none can set higher or lower than the rest—no risk of crimping the casing, no danger of an unequal grip that may fail in service . . . (4) Slips are set and packing is tightened around casing without stripping and without first cutting the casing. Simplifies installation—saves time!

"UPS" Heads also incorporate the unique Baash-Ross weld-testing feature which permits simultaneously testing the pressure-tightness of *both* casing welds with a gauge and hand pump as part of the installation procedure—or any time later. Any leaks discovered during the life of the well can be quickly sealed off by injecting plastic pack material.

"UPS" Equipment is available in a complete range of sizes . . . for threading or welding to the casing . . . with or without Bases . . . and for use with over a dozen different Tubing Heads Suspensions and Hook-Ups. *It is the ideal solution for a wide range of requirements on medium and low-pressure wells!*

View of Flange Installed showing packing arrangement.





BAASH-ROSS

TYPE "UPS-DF" HEADS

Offer "UPS" Advantages Plus Demountable Flanges

Type "UPS-DF" Heads combine all the "UPS" advantages with an additional important feature—*Demountable Flanges that can be salvaged after the drilling operations for use on other installations.*

The body, packing and slips of this design are the same as standard "UPS" Heads to provide all the important "UPS" advantages outlined at left. However, the flange is attached to the main body by means of a square thread so that it can be readily removed when drilling operations are completed.

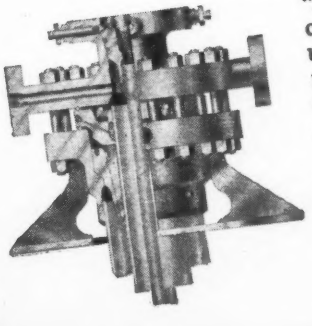
During drilling, the flange is installed on the Head to provide means for attaching standard pressure control. A unique packing arrangement—having important advantages over the conventional ring-groove design—prevents leakage between the flanges and is so placed that the square thread is not exposed to casing pressure.

After drilling is completed, the pressure control equipment is removed and the flange is unscrewed from the Head—an operation simplified by the easy make-and-break properties of the square thread. The flange, ring bolts and packing can then be used repeatedly on other wells, thus effecting important economies on multiple installations.

Available in a complete range of sizes and designs, Type "UPS-DF" equipment is the latest in a long string of Baash-Ross Landing and Casing Head advancements. *Be sure to investigate the economies this equipment can make for you!*

BAASH-ROSS TYPE "X" HEADS

Provide Vital Advantages for High-Pressure Installations.



Developed several years ago to give new efficiencies on high-pressure wells, Type "X" equipment has been widely used on wells of all depths and pressures. It offers an unusual degree of simplicity, compactness and ready-adaptability to different installation requirements, and the heavy-duty pack-off provides a dependable seal against the highest well pressures. The pack-off is made in a separate unit that fits between flanges—a pressure-tight seal being formed around the casing by a double-element Packing Assembly tightened by stud bolts.

TYPE "X" ADVANTAGES INCLUDE . . . (1) No grooves or threads in the bowl of the Head—therefore nothing to become damaged or corroded during drilling operations, nothing to require maintenance or protection . . . (2) The one-piece Packing Assembly mounts between flanges for simple installation, maximum saving in space . . . (3) Unitized Slips assure uniform slip pressure, freedom from casing damage . . . (4) The Packing Assembly as well as the casing weld are so designed that the seal around the casing can be checked at any time during the life of the well, and if a leak is discovered can be readily packed-off with plastic material *without dismantling the Head or even breaking connections.*

Type "X" Heads are unusually adaptable to varying completion requirements—permit changing series-ratings and flange sizes in the Heads—and have many other unique features. They are available in a complete range of sizes, pressures and variations to meet every well requirement!

CERTIFIED

Baash-Ross Landing, Casing and Tubing Heads are available through leading supply stores.

See pages 421 through 430 of your 1951 Composite Catalog for more data on Baash-Ross Landing and Casing Heads. Or write to your nearest Baash-Ross Sales Office.

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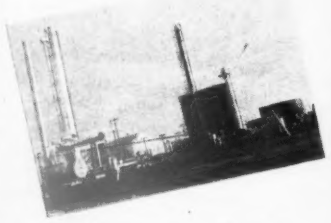
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tested. Test results are included in Table 10.

Preparation of Thread Compound for Field Tests. Results of laboratory tests have proved that certain experimental compositions meet the requirements of a satisfactory thread compound for deep high-pressure wells. Products capable of forming a permanent leak-resistant seal in threaded joints, and having lubricating properties comparable with those of the best commercial products were prepared. The most promising compositions contained a mixture of 2 to 4 per cent flake copper, 18 per cent graphite, and 42 to 44 per cent of a mixture of powdered lead and zinc (consisting of 2.35 to 3.17 parts by weight of lead to 1 part of zinc) dispersed in 34 to 36 per cent of the sliconebase vehicle. All test joints made up with such compositions proved lead resistant and the joint seal was not affected by vibration.

Field tests are necessary to provide final proof of the behavior of experimental compositions in commercial application. For this purpose, a large batch of the optimum experimental thread compound for use in field tests was prepared at the Philadelphia refinery of the Gulf Oil Corporation.

An aluminum soap base grease was prepared according to normal commercial procedure. A mixture containing 32794 g. (72.3 lb) of Richfield oil (West Coast Naphthentic Stock, vis. at 100 F. 205 S. S. U.) and 2135 g. (4.7 lb) of aluminum stearate (Witco No. 18 was charged into a 100-lb grease kettle and slurried. This mixture was then heated to 265-270 F with continuous stirring until completely gelled. The product was drawn off into shallow pans and held in a room at 32 F for 3½ hours, then held at room temperature over night.

The gel was returned to the grease kettle and worked for 20 min, including 5 min under vacuum. It was then forced under pressure through a 60-mesh screen to form a smooth uniform grease.

A mixture containing 16,904 g. (37.27 lb) of this grease, 2025 g. (4.46 lb) of Silicone Fluid XF-60* and 10.746 g. (23.6 lb) of Silicone Compound XC-118* (containing 5.8 per cent silica dispersed in Silicone Fluid XF-60) was charged into the kettle and stirred for 25 min (including 5 min under vacuum) at room temperature. A smooth uniform product was formed. To this was added 14,879 g. (32.8 lb) of graphite, 25,211 g. (55.53 lb) of lead, 10,167 g. (22.4 lb) of zinc, and 2728 g. (6 lb) of copper. The mixture was stirred at room temperature to disperse the filler in the vehicle.

This product shows a tendency to bleed during storage at room temperature. More rapid cooling of the aluminum stearate gel or a slight increase in the concentration of soap, or a combination, is necessary to produce a more stable thread compound.

Field Tests. The experimental API thread compound was applied to threads of 500 pieces of 2⅜-in. OD J-55 threaded and coupled upset tubing at the Aliquippa works of the Jones and Laughlin Steel Corporation. Couplings were applied and the mill-end joints made up power tight at constant torque. A similar number of joints were made up with each of two commercial thread compounds ("A1" and "B1"). All joints were mill tested to 3000-psi hydrostatic pressure, then field tested to 5000-psi hydrostatic pressure before shipment.

The joints were shipped to Harvey, Louisiana, and again pressure tested to 5000 psi hydrostatic pressure. One joint sealed with the API thread compound leaked in the field, whereas 8 joints sealed with commercial product "A1" and 72 joints sealed with compound "B1" failed to hold pressure.

In order to determine the possible effect of aging upon the seal, 100 joints from each lot were held for a period of two months. None of the joints made up with API thread compound or commercial compound "A1" showed any evidence of leakage. Four joints made up with commercial thread compound "B1" failed.

A similar test of the experimental thread compound has been made at the McKeesport works of the National Tube Company. The thread compound was applied to threads of 500 joints of 2⅞-in. OD J-55 threaded and coupled upset tubing and mill-end joints made up hand tight. Each joint was then made up an average of 2¼ turns beyond the hand-tight position. All joints were mill tested to 3000 psi hydrostatic pressure, and then field tested to 6600 psi hydrostatic pressure at the mill. These joints will be shipped to Houston, Texas, and again pressure tested to 80 per cent of the minimum yield strength.

Field tests of the experimental thread compound have also been made in cooperation with the Humble Oil and Refining Company. Two strings of 2⅞-in. OD J-55 threaded and coupled upset tubing, each approximately 7500 ft in length, were run with couplings floating. This is the standard make up practice specified for all tubing strings run by

*Dow Corning Corporation, Midland, Michigan.

Plastic-Coated Tubing Passes Corrosion Test

Manufacturers of plastic coatings have been working with petroleum technicians on the problem of corrosion in oil well tubing. At completion of a five-month test, ordinary pipe was corroded deeply after being subjected to a daily flow of 100 bbl of oil and 5000 bbl of iodized salt water. Preliminary tests indicated that pipe coated with vinyl plastic was unaffected. Benefits from production research like this are ultimately passed on to consumers in the form of increasingly plentiful supplies of oil products.

Humble Oil and Refining Company in high-pressure wells.

The tubing joints were made up to a minimum torque in the rotary table using air tongs. An air pressure of 60 lb, the tongs stalling at a maximum torque of 2400 ft-lb torque, was used in making up tubing joints in Well No. 1, Trawick Gas Unit No. 14. At this torque, make up of the field end varied from 0 to 2½ turns beyond the last scratch (average 1-7/16 threads). Mill end make-up averaged 2¼ turns beyond the handling-tight position (one man using a 36-in. wrench).

An air pressure of 55 lb, the air tongs stalling at 2200 ft-lb, was used to make up tubing joints in Well No. 1. Trawick Gas Unit No. 16. Make up of the field end averaged 1⅛ turns beyond the last scratch. The make up of the mill end averaged 1-15/16 turns beyond the handling-tight position, or 1⅛ turns beyond the last scratch.

Both tubing strings were pressure tight when the wells were brought in. These wells will be checked periodically for tubing joint leakage.

Discussion of Results

The experimental thread compounds formulated in the laboratory were evaluated by means of joint make up and hydrostatic pressure tests. The test results showed that certain mixtures of lead, zinc, copper, and graphite, dispersed in a suitable vehicle, provided adequate thread lubrication, and form a permanent leak-resistant seal.

The mixture of fillers selected for use in the product prepared for field trials was the one which gave the best results in laboratory tests. This formula is empirical, however, and slight variations within the specified limits have little effect on the properties of the product.

Copper functions as an active thread lubricant; and the concentration of copper in the compound may be varied. An increase in the copper content, from 2 to 4 per cent by weight, resulted in a 10 per cent decrease in makeup torque. Compositions which contained 3 to 4 per cent flake copper had adequate lubrication properties.

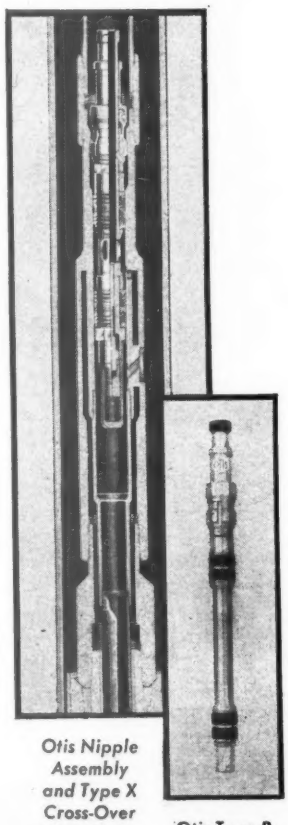
It is believed that the mixture of lead and zinc functions as the principal sealant. As stated previously, the test results show that the leak resistance of the seal formed by mixtures of lead and zinc do not vary with time. Also, this seal is resistant to vibration. Variations in the ratio of lead to zinc, within the limits cited, apparently do not affect the properties of the thread compound. When the concentration of zinc was increased beyond this limit, however, the makeup torque also increased; when the zinc concentration was decreased, the seal was less effective.

The particle sizes of the lead and zinc powders are not extremely critical. Products of which not more than 2 per cent is retained on a 48-mesh screen and not more than 75 per cent passes a 325-mesh screen, are recommended. All the products except Superfine "S" grade of lead powder, described in Table 5, are acceptable.

CROSS OFF THIS OLD WAY TO CROSS OVER

flow courses in two-zone wells

Otis "Selective" Cross-Over Nipple Assembly and Wire Line Chokes



Otis Nipple Assembly and Type X Cross-Over Flow Choke

Otis Type R Choke for Parallel Flow

The Otis service truck and the contractor's workover unit shown above are performing the same operation — crossing over the flow courses in a two-zone well. The Otis truck is on a well in which an Otis "Selective" Cross-Over Nipple Assembly is installed, and the Otis wire line crew has pulled an Otis parallel flow choke from the nipple and is going back in the hole with an Otis cross-over flow choke that will produce the upper zone through the tubing and the lower zone through the tubing-casing annulus. This is a simple and economical method of crossing over flow courses by means of wire line operations at the surface, at a minimum of downtime — making it unnecessary to kill a well and pull and re-run tubing to cross over. The Otis cross-over assembly consists of a landing nipple, a tail pipe, and a special sub to connect the Otis cross-over head to the packer (an Otis Type C, Baker Model D, or similar packers). The assembly is permanent sub-surface equipment run with the packer. After the packer is set and surface connections are made up, either the parallel flow or cross-over choke is run in and locked in the nipple, using a regular Otis high-pressure lubricator and wire line tools.

Before you complete — or recomplete — another well in these days of high production costs, ask your nearest Otis office for full particulars on this equipment. There's no obligation, of course.

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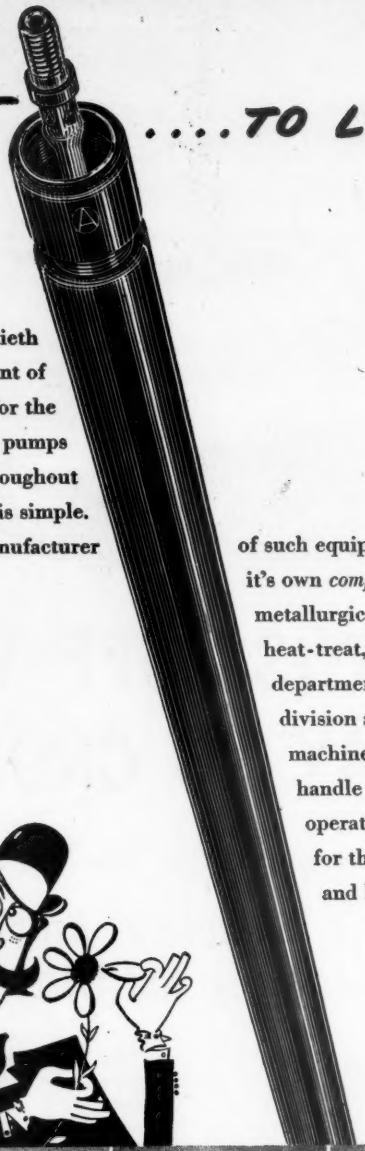

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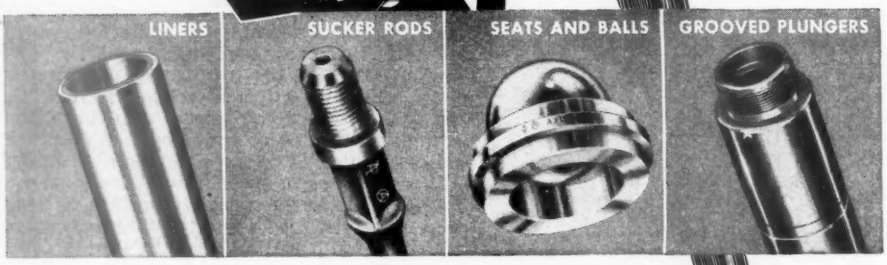

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The optimum composition of the thread compound has been defined. It may be modified, if desired. The concentration of copper may be varied, from 2 to 10 per cent; of graphite, from 5 to 20 per cent; of the mixture of lead and zinc, from 25 to 45 per cent; and of the vehicle, from 25 to 60 per cent. Such changes in composition, however, will affect all the properties of the product.

The tests of thread compounds prepared with petroleum-base vehicles are not complete, and definite conclusions cannot be drawn at this time. Certain experimental products have been shown to have satisfactory lubrication properties; but the degree of leak resistance of the seal has not been established. The test results are encouraging; therefore, this phase of the investigation is being continued.

The effect of degree of joint make up upon leak resistance, was not investigated. The average make up of laboratory test joints was 2¼ turns beyond the hand-tight position, or to a minimum torque (1750 ft-lb). Joints sealed with the API thread compound proved leak resistant when pressure tested at 9000-10,000 psi hydrostatic pressure.

Tests at the Youngstown Sheet and Tube Company, on 2⅜-in. and 2⅞-in. tubing, disclosed that a minimum of 2 threads make up beyond the handtight position is necessary to insure leak resistance under an internal pressure of 6000-7000 psi hydrostatic pressure. These results indicate that 2 to 2½ turns beyond the handtight position may be adequate to provide a pressure-tight seal. These data, however, which are incomplete, are for only 2⅜-in. and 2⅞-in. OD upset tubing. It is recommended that further tests be made to determine the optimum degree of make up for joints in all standard sizes.

Assignment

The results of this investigation on pipe-thread compounds are the property of the sponsor, the American Petroleum Institute. In conformance with the general policy of that organization, the information presented in this paper is released for public use.

Acknowledgment

The author wishes to express his appreciation to the following pipe manufacturers for their cooperation in providing tubing and couplings required for test purposes and for making their equipment available:

Jones and Laughlin Steel Corporation; National Tube Company; Pittsburgh Steel Company, Spang-Chalfant Division of the National Supply Company, and Youngstown Sheet and Tube Company.

The author is equally indebted to the following oil companies for their valuable suggestions and cooperation in the laboratory and field testing of experimental products:

Gulf Oil Corporation, Humble Oil and Refining Company, Phillips Petroleum Company, Richfield Oil Corporation, Shell Oil Company, and Stanolind Oil and Gas Company. * * *

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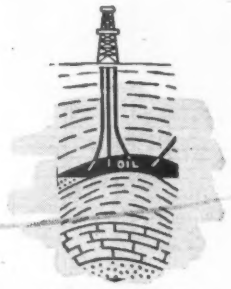

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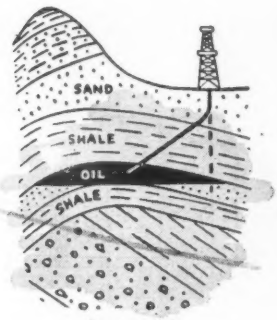
Eastman Directional Drilling was first used to explore productive zones off the California Coast by drilling wells from shore to subsea formations. Since that time many new applications of DIRECTIONAL DRILLING have been made by competent Eastman engineers to the extent that Directional Drilling now is utilized extensively and applied successfully in the following manner: EXPLORING geological structures by drilling multiple wells from single locations; EXPLOITING new oil reservoirs; DEFLECTING the course of the well to reach otherwise inaccessible bottom locations; SIDETRACKING obstructions and STRAIGHTENING the hole; REDRILLING old wells profitably; and CONTROLLING wild wells.



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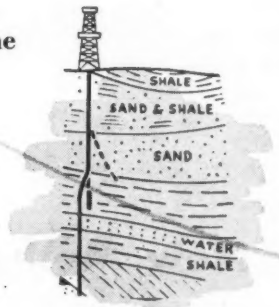
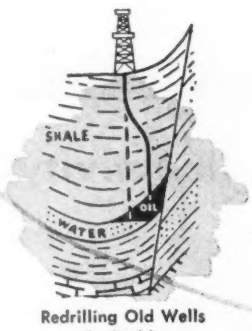
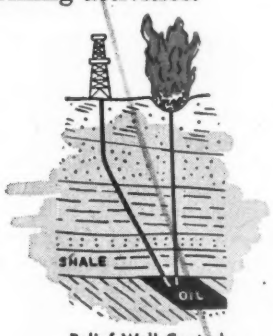


Straightening and Sidetracking



Redrilling Old Wells Profitably



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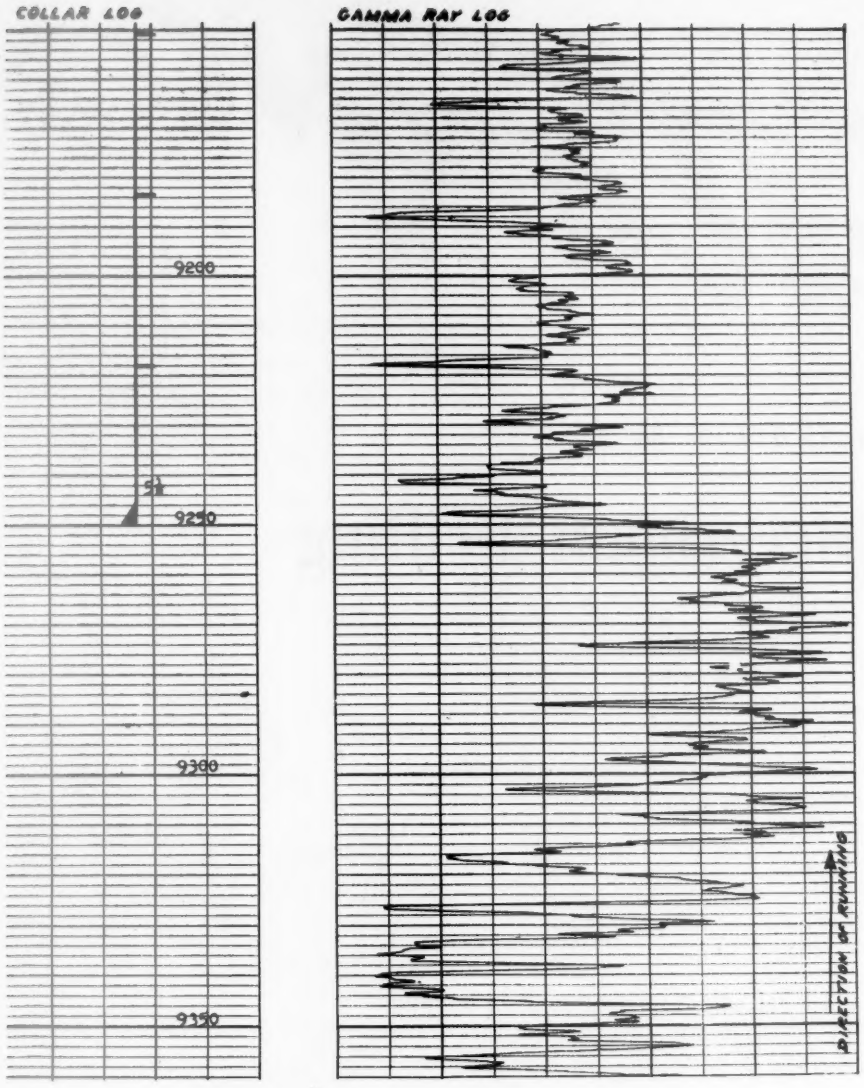

Unretouched photograph showing section of actual log produced with the new McCullough radiation well logger. Note detail and absence of lag or drag at formation edges.

New Method Advanced for Determining Radioactivity

Accurate logging of even the thinnest beds in an oil well is now possible with a new method of detecting radioactivity, recently introduced by the McCullough Tool Company, Los Angeles. This development, the radiation well logger, is reported to permit more accurate interpretation and correlation.

It was formerly thought impossible to decrease the length of the counter in a gamma ray logger and at the same time increase its sensitivity. It has been acknowledged that if such a counter could be developed, a sharper, more accurate log would result. The company states that this well logger has accomplished this as well as increasing the running speed of the logger.

The counter in the radiation well logger is the McCullough Scintillometer—a solid counter. Because of its high density, it is capable of detecting practically all gamma rays striking it. It is shorter in length than the radius of any hole it may be run in, yet more sensitive.

This shorter length plus its sensitivity permits thin beds from 12 ft down to one ft and even less, to be accurately located and logged, it has been reported.

Some of the most difficult zones in Texas and California have been logged with favorable results in recent months. New, thin producing zones have been located with this new device.

The Scintillometer is not electrically excited. Measurements made are independent of electrical leakage and only radioactivity is measured.

The sensitivity of the new McCullough Scintillometer permits greater detail and accuracy in the completed log, it was said, because of:

1. It is equally sensitive to high and low energies. (No electrical background count—only radioactivity affects the counter).
2. The high count rate permits increased running speed and a decreased time constant, which results in less lag or drag at formation edges.

Other features that make interpretation easier, and more accurate are reported to be:

1. Original log does not need retouching.
2. Instrument is calibrated in international units permitting quantitative measurements of radioactivity. Absolute zero is stable and may be checked at anytime while logging the well.
3. Time constants are variable in known steps and can be checked or changed at anytime during logging operations.
4. As it has no temperature or instrument drift it can be used as a future reference tool. The calibration-sensitivity or operating point does not change during the life of the instrument.
5. It records a broad band of radiation waves and only part of the band may be measured if desired.
6. A collar log is made simultaneously.
7. It correlates more accurately with electric logs and cores. * * *

New Maps Are Available Covering Williston Basin

The D. A. Austin Company, Fort Worth, Texas, has announced publication of a new map known as the "Williston Basin Map," covering recent oil discoveries in North and South Dakota and Montana.

All of North and South Dakota and Wyoming are covered in their entirety by the map, as well as central and eastern Montana, central and northern Nebraska, and a small portion of western Minnesota, and western Iowa. The map shows all counties within above areas, as well as townships and range lines, and county seats.

All drilling wildcat wells, new locations, recent discoveries, and dry holes will be shown on the map. Also included is a weekly report in the margin of the map, completely describing the latest locations and wildcat wells by states and counties, as well as their current drilling depths from latest reports.

The map scale is approximately 15 miles to one inch. Overall size is 42 by 48 in. The price is $10, paper, and $17.50, cloth.

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LOOK FOR THE GREEN RODS

NEWS

Arizona Adopts New Oil and Gas Regulations

The State Land Commissioner of Arizona has adopted new rules and regulations governing the administration of that state's new oil and gas conservation law. The rules include for drilling procedure, the establishment of a gas-oil ratio of 2000 cu ft of gas per bbl of oil, and a spacing unit of 40 acres for oil and 640 acres for gas wells.

Steel Is Set Aside for Emergency Wildcat Needs

The Petroleum Administration for Defense has announced that 22,200 tons of steel have been set aside in regional warehouse centers for emergency use by operators drilling wildcat tests.

The monthly tonnage set aside for emergency wildcat needs include: Los Angeles, 700 tons; Casper, Wyoming, 900; Ellinwood, Kansas, 300; Great Bend, Kansas, 300; Grayville, Illinois, 350; Oklahoma City, 600; Mount Pleasant, Michigan, 200; Houston, 400; Alice, Texas, 300; Odessa, Texas, 1500; Wichita Falls, Texas, 400; Shreveport, Louisiana, 500; Harvey Louisiana, 400; Charleston, West Virginia, 250; and Ballinger, Texas, 300.

Kewanee Publishes Account Of Waterflood Project

Kewanee Oil Company of Tulsa, Oklahoma, has published a leather bound booklet titled Mid-Burbank Unit, describing its water flood project in the South Burbank field, Osage County, Oklahoma.

The booklet, which is an historical and statistical treatise upon developments and activities precedent and incident to the inception of the secondary process of waterflooding, is divided into 6 parts with thumb indexes. It also contains a section of maps, figures, and diagrams to illustrate the project.

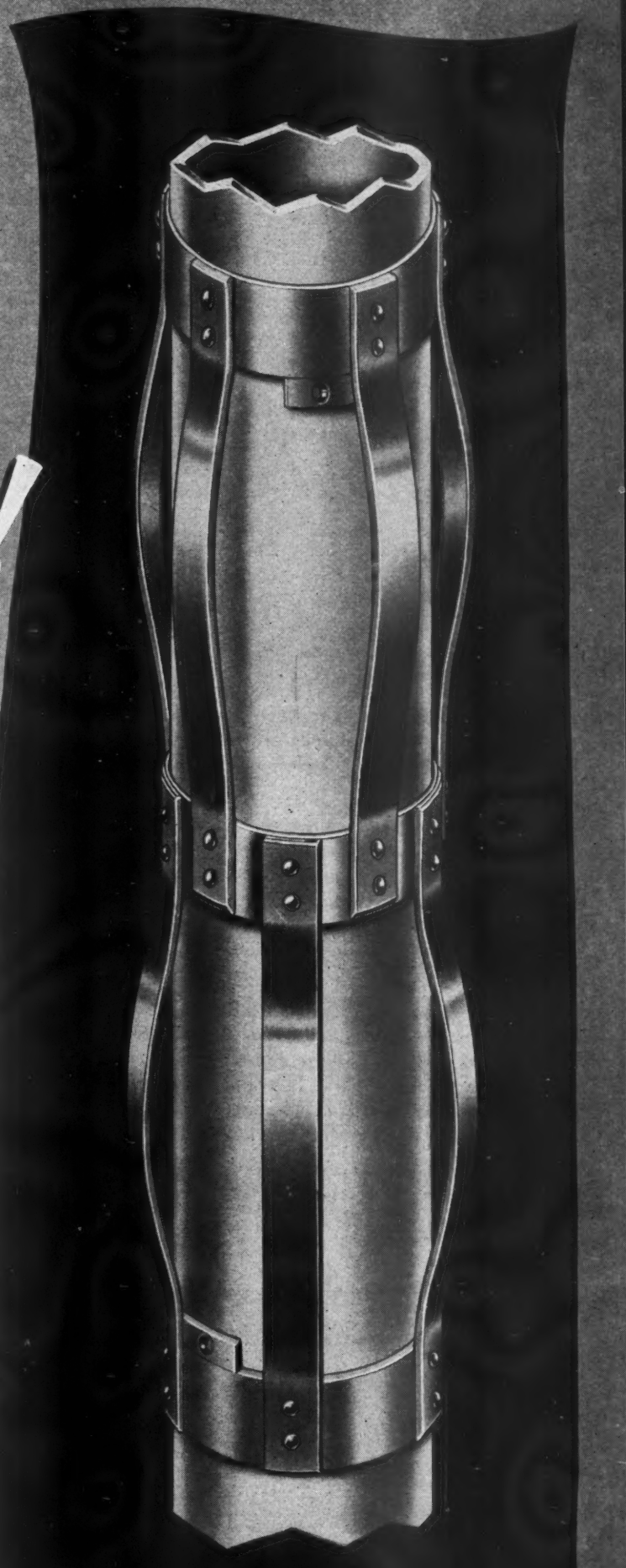
Superior Wins Concession Off Persian Gulf Coast

Superior Oil Company of California has been granted oil rights on the continental shelf along part of the Arabian Persian Gulf Coast. Section involved is off the coast of Abu Dhabi, a principality in Arabia ruled by Sheikh Shakhbut Bin Sultan Bin Za'id.

Superior's right to the grant had been contested by Petroleum Development, a company associated with the Iraq Petroleum Company, a British concern, which had claimed that a 1939 concession granted them the rights to this area. The Sheikh argued that the British company's grant included oil rights in the sea bed lying under the territorial waters of the Abu Dhabi. The case was settled by Lord Asquith of Bishopstone, who heard arguments from both companies in Paris this summer. Lord Asquith ruled that Petroleum Development's concession included the subsoil of the territorial waters, but not the subsoil of the continental shelf.

Map courtesy Stuler Map Company, Phoenix, Arizona.

FOR ONE JOB *well done!*



The one and only job of a centralizer is to keep casing centered in the hole under every condition whether rotating, reciprocating or stationary.

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- All 10 of the staves work as a unit, providing a centering strength many times greater than the conventional Centralizer.
- Casing may be rotated without rotation of the Centralizer.
- It provides a greater peripheral bearing on the wall of the hole. The staves are staggered to give 10 points of contact.
- The original "Tailor-Made" to hole size Centralizer. No on-the-job adjustments necessary.

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Spacing Suit Decision Favors Oil Companies

Carter Oil Company and others won a victory in Oklahoma recently, when that state's supreme court ruled that the Corporation Commission cannot revise an oil well spacing order without giving notice to all interested parties.

The decision involved a 1948 order of the Oklahoma Corporation Commission, modifying a 1947 spacing order in Garvin County. Carter and other parties with investments in Garvin County oil production had appealed to the high court on the grounds that they had not been notified in advance and had had no time to present opposing arguments.

R. C. Tucker Announces Change of Firm Name

R. C. Tucker, president of George P. Livermore, Inc., has announced a change in the firm name of George P. Livermore, Inc. The new name will be Great Western Drilling Company and the change is now in effect.

Great Western Drilling Company operates some 20 rotary drilling rigs in West Texas, New Mexico, Colorado, Oklahoma, and Kansas and also has oil production in most of these areas.

The change in firm name will in no way affect operation or company policy, Tucker stated. The change is merely one in name and the present officers and personnel will continue in their present capacities. Headquarters will remain in Lubbock with branch offices in Midland, Texas, Denver, Colorado and Farmington, New Mexico.

R. C. Tucker

Tucker came with George P. Livermore, Inc., and the Great Western Producers, Inc., in 1945 as vice president and was elected to the presidency in July 1951. He has 32 years experience in the oil industry with the past 19 years in the West Texas area.

Survey Planned for Trinidad Gulf Area

A seismic survey is to be made early this year in the Gulf of Paria, off Trinidad, to search for geological structures suitable for underwater drilling, according to Anglo-Iranian Oil Company. Trinidad Northern Areas Ltd., in which the D'Arcy Exploration Company, Trinidad Leaseholds Ltd., and United British Oilfields of Trinidad (Shell) have a third interest, will carry out the survey.

Several wells have been drilled in the company's concession area on Trinidad Island at a cost of more than $2,800,000, but without result, Anglo-Iranian Oil reports. Plans are to extend the search to the seabed.

Austrian Drilling Carried To 1000 Ft, USBM Reports

Prospect drilling to a depth of 1000 ft was undertaken at the beginning of last year between Lebring and Radkersburg, the U. S. Bureau of Mines International Petroleum Trades states, basing its information upon reports in the Austrian daily press. Earlier sensational reports of deep drilling planned or already begun in Styria, Austria, may be considered at least premature, the bulletin added.

Saudi Arabian Output Up

Crude oil production in Saudi Arabia during November amounted to 26,900,263 bbl, or an average of 896,675 bbl per calendar day, it was announced by the Arabian American Oil Company. This compared with 26,290,361 bbl produced in October, or an average of 848,076 bbl per calendar.

Crude oil production for the first eleven months of 1951 amounted to 251,494,159 bbl, an average of 752,977 bbl per calendar day.

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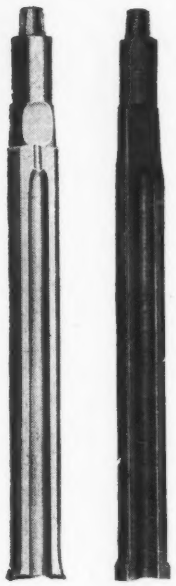
PRESERVE YOUR FREEDOM!

It is not enough to select the best person for each political office, work for his nomination, and vote for, and elect him to office on election day.

We must keep ourselves fully informed on current issues and their effect on us *and* our countrymen . . . and persistently acquaint our representatives with our view on these matters. He wants to know what we think, and will reflect our views in his actions.

We can't depend on others to do this for us, if we are to preserve freedom for ourselves and our children. It is no "let George do it" task; nor a job for clubs, associations, and other groups alone. It is an important obligation that you and I, each as a responsible citizen, must accept individually.

Write, call, or personally visit your political servants. It is your privilege, duty, and opportunity.



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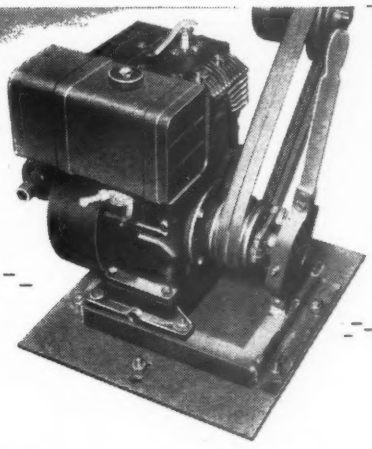

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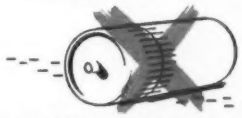

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Louisiana, and New Mexico

To obtain more information on products advertised see page E-41

Williston Basin Covered In Aerial Photography

New stereo photo coverage for the entire Williston Basin area is now available, it was announced by Aero Service Corporation. The Philadelphia aerial mapping company said the photos are being compiled in controlled mosaics at a scale of 2 in. equals 1 mile. Each mosaic is in the form of a 15 minute quadrangle and covers over 200 sq miles.

The aerial photography was flown this fall. Approximately 50,000 sq miles in North and South Dakota and Montana were covered. An additional 10,000 square miles of aerial photo coverage in the Dakotas is scheduled for 1952 flying by Aero Service.

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may be the answer to your problem!

Customers tell us that even the other equipment, above and below ground, seems to do better and last longer when a JENSEN lifts the oil.

And why not? We have made and studied pumping equipment for more than 30 years. Why don't you take advantage of this valuable experience?

When you get the facts we believe you will agree that a JENSEN is the answer to your pumping problem. See your dealer or write Coffeyville today.

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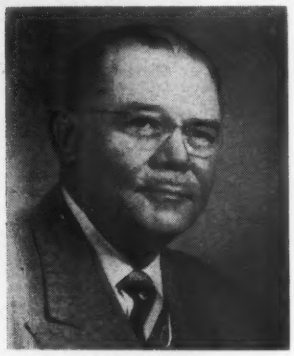
Payton Pool Unit Formed for Water Flooding Plan

The British-American Oil Producing Company is unit operator for the Payton pool Yates sand unit recently formed for water-flooding the Yates sand in the Payton Pool, Ward and Pecos counties, Texas.

This unit comprises 2157 acres in 25 separate tracts. It is planned that about 80 new injection wells will be drilled to permit execution of a pattern waterflood. A few of the old producers may be converted for use as injection wells. Existing wells will be used for production during the first stage of waterflood operation, but it is expected that approximately 64 new producing wells will be required before completion of the project. Engineers estimate that the development and operation of this flood will cover a period of about 10 years.



N. P. Whaley
in charge of unit operation

The Payton pool was discovered in 1937 and had produced over 3,000,000 bbl of oil prior to formation of the unit on November 1, 1951. Many of the leases in the field were approaching the economic limit for primary operation. It is expected that additional oil to be recovered by water-flooding will amount to 1½ to 2 times the recovery that has been obtained under primary operation.

Field operations for this unit will be handled through a local office recently established by British-American at Monahans. N. P. Whatley is unit superintendent in charge of the Monahans office.

Companies participating in the unit besides British-American are: Brandor Petroleum Company, Dallas, Texas; Burk Royalty Company, Wichita Falls, Texas; Cities Service Oil Company, Bartlesville, Oklahoma; Roeser and Pendleton, Inc., Fort Worth, Texas; Ja-Chel Oil Company, Dallas; Herschel Jaffe, Dallas; W. L. Todd, Jr., Dallas, and Hall Walker, Ranger, Texas.

Magician Mystifies Nomads at Los Angeles Shindig

Harry Mendoza, a modern Merlin, teacher of magic to the stars, provided some feats of magic and sleight-of-hand tricks that completely fooled those attending a recent meeting of Los Angeles Nomads at the Jonathan Club. With magic rings, disappearing eggs, self-mending rope, and other aids guaranteed to mystify an audience—Mendoza put on an outstanding show.

Earl Rees presided in the absence of Jerry Engstrand. Entertainment was arranged by Jim Hughes, Sergeant-at-Arms.

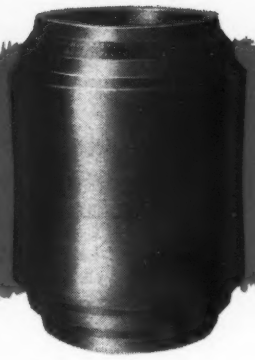
In the accompanying picture are: Front row: Juan Pedretti, Union Oil Company of California; Elmer E. Jones, British Oil Corporation, Venezuela; E. J. Radous, Shell Caribbean Petroleum Company; Buck Devine, Iraq Petroleum Corporation; R. R. G. Rivington, Asiatic Petroleum Corporation.

Back row: Russell Keener, Petro Tech Service Company; George Tolmachoff, National Supply of Venezuela; Arnoldo Rojos, Empresa Nacional del Petroleo, Chile; Mario Infante, Empresa Nacional del Petroleo, Chile; Roberto Blackwood, Empresa Nacional del Petroleo, Chile; J. W. Clampitt, Iraq Petroleum Company; John M. Miner, Petro Tech Service; H. G. "Beans" Rice, Bob Eiche and Associates, Venezuela and Colombia. Not pictured: R. J. Kettenburg, Asiatic Petroleum Corporation; Ernest Smith, Socony Vacuum Oil; Mike H. Bush, Southeastern de Mexico.

Party Chiefs Hold Meeting

The annual meeting of the party chiefs of the National Geophysical Company, Dallas, Texas, was held at the Cosmopolitan Hotel in Denver, Colorado, recently. Technical subjects and new developments were discussed. Personnel from all over the U. S. attended.

...offers you these features!



DRILL PIPE PROTECTORS

Weatherford Drill Pipe Protectors are supplied in all fields and installed quickly with the Weatherford Applicator.

U. S. and Foreign Patents pending and issued.

WELL CONDITIONS ENCOUNTERED BY DRILL PIPE PROTECTORS

1. Rough treatment coming out of and going into the hole.
2. Drilling abrasives of various sizes passing the outer diameter of the protector.
3. Wide range of temperature (from pipe rack to the bottom of the hole).
4. Oil and gases under a wide range of pressures.

HOW WEATHERFORD PROTECTORS OVERCOME THESE CONDITIONS

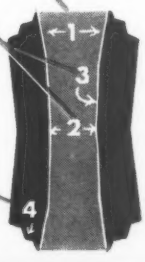
The following features are found in Weatherford Protectors only:

1. Larger inner diameter at the ends, tapering to a smaller diameter at the center. When installed, the ends of the protector will not be stretched as tightly as the center and the likelihood of tearing is greatly reduced. (Protectors lacking this feature are easily torn).

2. As the smallest inside diameter of the protector is at the center, the rubber stretched to the greatest degree is shielded from bruising by its tapered ends. This affords maximum gripping power at the middle section which expells and prevents ingress of fluids between the protector and drill pipe. Thus lubrication, which is one of the major causes of slipping on the pipe, is eliminated.

3. The inner wall of the protector, which grips the drill pipe, is perfectly smooth. Tests have proved that a smooth rubber surface against a smooth metal surface gives the best adhesion and gripping qualities.

4. The stepped and tapered design breaks the turbulence of the passing mud flow, thus protecting the pipe and protector from abrasion.



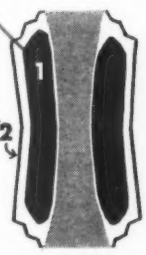
ADDITIONAL ADVANTAGES OF WEATHERFORD OIL-RESISTANT PROTECTORS

1. Natural rubber is used for the core of this protector, affording better gripping qualities and resilient durability over a larger range of temperatures.

2. Since natural rubber does not provide adequate resistance to the deteriorating effect of oil and gas a resistant cover of a different character is essential. Synthetic rubber is therefore used for the outer shell or cover, since it does resist the effects of oil and gas.

For the above reasons the Weatherford Protector, with the oil and gas resisting synthetic rubber cover, meets the deteriorating conditions encountered in oil wells more satisfactorily than does any other protector.

Therefore, we guarantee all Weatherford Oil and Gas Resistant Protectors against slipping on the pipe, the effects of extreme temperature, and the absorption of oil and gas.



We also guarantee our natural rubber protectors against slipping on the pipe and the effects of extreme temperatures, but NOT against absorption of oil and gas.

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WHAT'S DOING IN DRILLING

Texaco Well Finds New Producing Zone

The Texas Company has announced the discovery of a new producing horizon in Cote Blanche Island field, St. Mary's Parish, Louisiana, with the completion of Cote Blanche Island No. 20 as an oil well.

Drilled to 14,446 ft, the Texaco well was perforated from 14,387-14,426 ft and flowed at the daily rate of 456 bbl of 29.8 gravity oil through a 10/64-in. choke. Tubing pressure was reported as 2400 lb and the gas-oil ratio, 788 to one.

The location is under water on the state of Louisiana lease No. 340, Cote Blanche Island dome area, and is a mile east of the nearest production. Of 19 tests drilled previously on the lease by the company, two were small shallow producers.

New Deep Producing Zone Hit in Mississippi Field

A new producing depth of 13 to 14,000 ft has been set in the Tensley field, Yazoo County, Mississippi, with completion of Union Producing Company-Jones-O'Brien's wildcat. The well flowed at the rate of 2,439,000 cu ft of sour gas plus 68 bbl of 55.8 gravity condensate per day through 7/6-in. choke. It has been completed for a shut-in, low-volume, sour-gas well, and completion was made in third side-tracked hole, which is open from window in casing at 13,985 ft to total depth of 14,427 ft in Smackover. Tubing pressure is 6200 psi, and casing pressure 1700 psi.

Plymouth Well Completed

Plymouth Oil Company has reported a new well in the Benedum field, Upton County, Texas. Drilled to a depth of 7565 ft, the new well flowed 516 bbl of oil daily on a 3/8-in. choke in initial tests. Known as the Plymouth-Neal No. 2-8, it has a gravity rating of 41.8, and a gas-oil ratio of 650 to 1.

Rotary rigs operating in oil fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Illinois Oklahoma Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texas
(November)							
Third	3116	651	175	689	188	262	1051
Fourth	3134	662	177	681	194	359	1061
(December)							
First	3164	679	180	695	190	348	1075
Second	3164	667	179	721	195	350	1069

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

New Discovery Seen Lea, New Mexico

On a drillstem test in the Jackson, Douglas, and Ritchie No. 1 State, eight miles northwest of the Bagley area of Lea County, New Mexico, shows have been found for a possible Permo-Pennsylvanian discovery. The wildcat was tested in between 8198 and 8244 ft, and the tool was open 4 hours and gas surfaced in one hour, 45 minutes. It blew steadily for the remainder of the test. Recovery was 100 ft of oil and gas cut mud.

Olsen Oil Well Flows 373 Bbl of Oil in 24 Hours

R. Olsen Oil Company has completed its No. 1 Feldman in the Hermleigh Ellenburger field, Scurry County, Texas. The new well flowed 24 hours through a 5/16-in. choke to make a potential of 373 bbl of 42.3 gravity oil and no water. Production, which includes gas volume of 200,000 cu ft per day, is coming from open hole in the Ellenburger between 7301 ft, where 7-in. casing is set and total depth is 7386 ft. This is the second producer in the Hermleigh Ellenburger field. The R. W. Baxter No. 1 Feldman is the discovery well of the field, and has since been plugged and abandoned.

Burmah Oil Inaugurates New Oil Drilling Program

Thakin Nu, Prime Minister of Burma, inaugurated a new Burmah Oil Company drilling program at Chauk oil field in central Burma recently by operating controls at the first well to be drilled since the war.

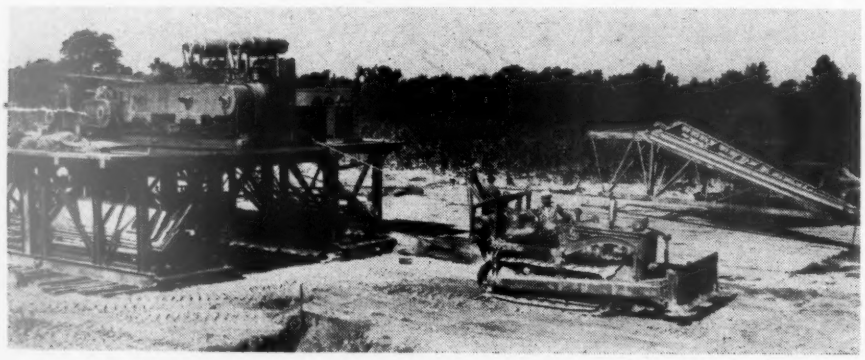
Watched by a large crowd of oil field employees and local officials the Prime Minister spudded in the new well by drilling the first few feet of hole.

This ceremony marked the resumption of post-war drilling at Chauk whereby a limited number of new wells will be sunk, and some pre-war wells deepened, to maintain crude oil throughput to the refinery at the maximum practicable level in prevailing conditions.

After being welcomed by W. P. G. Maclachlan, BOC manager at Chauk, the Prime Minister stepped up to the driller's position on the derrick floor and set in motion the "National 50" outfit by which the new well began drilling. He drilled two or three feet of hole before handing over the controls to the field's Burmese drilling crew. The Prime Minister then inspected the rotary equipment before rejoining guests in a decorated dais specially erected for the occasion alongside the derrick.

In the course of his speech to oil workers at the site of the new drilling operations the Prime Minister referred to the proposed joint oil venture saying: "With the assistance of the British Government and the oil companies we shall be able to acquire a considerable share in the local Burma Oil industry. We are confident of a successful conclusion to the J. V. discussions."

Big Shift. In addition to helping position drill rig near Magnolia, Arkansas, this International TD-14 tractor also dug slush pit and reserve mud pit on the site. Frank Connor, oil field contractor of Magnolia completed the entire job within 24 hours.



New Well Drilled in Old Illinois Producing Area

In Wabash County, Illinois, John Liaskos has a new well, the No. 1 Keepes drilled in an old producing area. The well swabbed 168 bbl of oil a day naturally from the McClosky limestone at 2624 to 2629 ft. The well will increase activity from this old pool.

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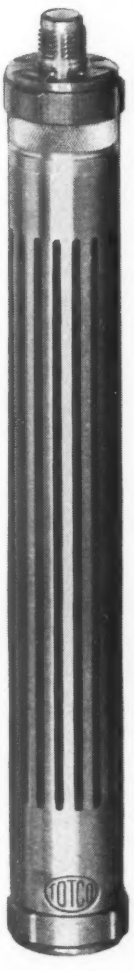

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A major oil company wrote, "99% of our TOTCO runs have been *okay to be logged.*" That kind of reliability is possible because TOTCO is the most dependable, precision-built instrument in the oil fields—no expense has been spared in its manufacture.

Whenever and wherever you need a drift indicator, TOTCO field representatives can be relied upon to get you what you need when you want it. You can depend on TOTCO instruments and on TOTCO men—they'll both serve you well.

Be **SURE** *you know, use* **TOTCO**

YOU CAN TAKE TOTCO READINGS ANYTIME

Run in and out on measuring line.

Dropped down drill pipe; picked up with core barrel overshot.

Dropped down drill pipe; recovered when bit is changed.

Run in the Recorder connected to a core barrel overshot when picking up a retractable core barrel.

Run in and out on ordinary sand line.

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Ohio Oil Deepens Well In Denver-Julesburg Basin

Ohio Oil Company is deepening the No. 3 Pahl in the Huntsman, Nebraska, pool. The Huntsman pool is the largest oil and gas pool developed to date in the Denver-Julesburg Basin. The No. 3 Pahl is in the center of the Huntsman pool, and will be carried down to granite. Rotary equipment is being used for the deepening process. The well was drilled to the Dakota and suspended at 4733 ft.

Gulf Opens New Zone In Texas Oil Field

Gulf Oil Corporation has opened a new oil zone in the Ellenburger lime zone in the Sand Hills-Holt field Crane County, Texas. The company's well is the No. 7-E Estes, which was originally an old Holt zone producer at 4900 ft, was deepened to 8019 ft and casing perforated at 7925-50 and 7070-95 ft. On initial test it flowed 108 bbl of 45-gravity oil in three hours through a 1½ in. choke on tubing. Gas-oil ratio was 2044-to-1.

Sterling Drills New Gas Well

Sterling Oil Company of Oklahoma, Inc., has a gas-distillate producer completed on the north side of the Southeast Spring Valley pool in Garfield County, Oklahoma. It is the company's No. 1 Schroeder, which was acidized with 4000 gal and flowed 7,500,000 cu ft of gas per day with 25 bbl of distillate per 1,000,000 cu ft of gas. Total depth is 5531 ft with casing landed at 5470 ft.

Third Largest Producer Completed in Texas Field

The third largest well in the field has been completed in the Wilshire-Ellenburger field of Upton County, Texas, with completion of Sinclair Oil and Gas Company's No. 5 McElroy Ranch. The new well has been given a daily potential of 3170 bbl of high-gravity oil a day. The high potential was third largest for that field. Completion was through open 2-in. tubing from 12,265-12,325 ft. Flowing pressure was 400 psi.

Shell Drills Oklahoma Well

Shell Oil Company has completed its No. 1 Rumberger in Beckham County, Oklahoma, for a flow of 372 bbl of 40.5 gravity oil in 24 hours through a 22/64-in. choke. The new well, with a plugged back depth of 10,053 ft, had a gas-oil ratio of 4413 to 1. Production is from perforations between 9905-25 ft and 9924-47 ft.

Wyoming Well Completed

Sinclair Oil and Gas Company has completed a new well in Natrona County, Wyoming in the East Salt Section. It is the No. 1 East Salt Creek A, which has been drilled to 5962 ft and swabbed 203 bbl of 35-gravity oil in 21 hours. Production is from the Lakota Sand through perforations at 5910 to 5950 ft. The company is completing the well dually from the Wall Creek sand and the East Salt Creek section.

Elk City Well Flows 917 Bbl of Oil in 24 Hours

Shell and Continental Oil Companies have a large producer in the Beckham County, Oklahoma, sector of the Elk City field. It is their No. 2 Miller, plugged back to 10,098 ft, which flowed 917 bbl of 50.7 condensate in 24 hours through a 22/64-in. choke with a gas-oil ratio of 2823 to 1. Production is coming from perforations between 10,000-10,032 ft.

New Zone Producing In Arkansas Pool

Marine Oil Company has opened a new producing zone in the North New London field of Union County, Arkansas, with its No. 1 Pine. The new zone is in the Smackover lime. Reperforated from 6046-60 ft, the wildcat flowed an estimated 100 to 150 bbl of oil.

Atlantic Drills Well In Mississippi Pool

Atlantic Refining Company has added another well to the Church Hill field in Jefferson County, Mississippi. It is the company's No. 4 W. W. Lisbony, which flowed at the rate of 85 bbl of 38-gravity oil per day through ¼-in. choke. Tubing pressure varied between 75 and 100 lb, and casing pressure was 350 lb.

The oil flow is coming from perforations at 5546-49 ft. Hole has been bottomed at 5620 ft, and was cased to 5625 ft with 5½-in. pipe for the completion.

Spring Sand Yields Both Gas and Oil

The Little Nick Oil Company has proved the Spring Sand zone in southern Oklahoma a major source of natural gas as well as oil. The company based its findings on its No. 6 Rouce in the old Cement field of Caddo County, Oklahoma. Drillers set pipe at 6240 ft, cutting a fault zone in the field at 6800 ft, total depth. Between 6010 and 6555 ft, 252 productive feet were found and the well flowed at an estimated rate of 200,000,000 cu ft of gas daily, with a spray of distillate. The Cement field was discovered in 1916, with a small shallow gas well, and at the present time is producing from 18 separate zones.

Tide Water Gets Good Well

Tide Water Associated Oil Company, Western division, has announced successful completion of its Fernando 35 well, Aliso Canyon field, California, flowing at the rate of 658 bbl net oil per day. Production is from a total depth of 7,203 ft.

Extends Louisiana Field

Justiss Mears Company has extended the Trout Creek field of LaSalle Parish, Louisiana, one half mile with completion of its No. 1 W. L. Valentine. Oil sands were logged in the Wilcox at 3654-66 and 3678-93 ft. Bottomed at 4151 ft, the test has 5½-in. casing set to 3755 ft.

Tour Emsco Plant. One of several groups of oil executives, engineers, buyers, and field men who have recently visited the sucker rod plant operated by Emsco at Garland, Texas. In the front row are: C. K. Trease, Continental Supply, Oklahoma City; Eugene Fisher, Chester U. Burk, division mechanical engineer, Continental Oil Company. Back row: F. A. Lichtenheld, division engineer, Cities Service Oil; Joe F. Cook, D–B Division, Emsco Derrick and Equipment; John Miller, superintendent of production, Peppers Refining Company; H. T. Oliphant, Well Servicing foreman, W. B. Buck, superintendent, Phillips Petroleum Company; J. R. Govett, petroleum engineer, Continental Oil. D–B Division and Continental Supply were joint hosts on these recent series of plant tours. Garland visitors were flown from points as far away as New York City and back home again on the same day.

A STATEMENT by . . .

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PRESIDENT and CHIEF ENGINEER

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WICHITA FALLS, TEXAS

EXPLORATION ACTIVITIES

Shell Has Two Wells in New Montana Oil Area

Following a production test, Shell Oil Company has confirmed the completion of its Northern Pacific No. 1 well in the Richey area, Montana, flowing 1656 bbl of 38-gravity crude oil in the first 24 hours, according to an announcement by J. E. Clark, Rocky Mountain division manager in Casper, Wyoming. The well, situated on land held under contract with the Northern Pacific Railroad, is producing from the interval 7183 ft to 7275 ft from limestone of Mississippian Age.

News of this completed wildcat well comes approximately four and one-half months after the discovery of an important new oil-producing area in the Montana part of the Williston Basin was made known by Shell. Based upon a 40-minute drillstem test in July, Shell's Northern Pacific No. 1 was the first well in that part of the Basin to flow substantial quantities of oil during its initial test.

Clark emphasized that commercial production from the well marks only one step in a long exploratory and development process which began more than a year ago and will proceed for years to come. The first step was geophysical prospecting over a period of many months. On the basis of data thus obtained, the location of the exploratory well was decided upon and Northern Pacific No. 1 was "spudded in" in May, 1951.

Drilling had proceeded to the present producing depth when the first oil was struck July 13. The company continued drilling, however, to a depth of 10,518 ft, making tests in various formations to obtain a better picture of the potentialities of the area. The well was finally plugged back to the Mississippian formations and put on production.

Shell Oil plans to begin a second well in the field at an early date, as well as another exploratory well, Clark said, but the full extent of the field will not be known until a number of additional wells have been drilled. The company has surveyed five tentative locations.

According to Clark, completion of Shell's Northern Pacific No. 1 now confirms as correct the prediction made in July that the Montana part of the Williston Basin would be an important new producing region that may add substantially to the nation's crude oil reserves.

Shell Oil Company has completed what appears to be one of Montana's most important oil strikes at its No. 1 Pine Unit in Wibaux County. The new well also extends production in the Williston basin over a wider area at 2 spots. The Ordovician was hit at 9021 ft to 9746 ft. The well flowed 82 bbl of oil and 52 bbl of water the first 12 hours of the test, and in the next 12½ hours it tested 112 bbl of oil, cutting 4 per cent water. The oil tested 29 gravity.

North Dakota Well Extends Williston Basin

Latest oil strike in the North Dakota area of the Williston Basin is the No. 1 Math Iverson, drilled by M. B. Rudman and Critchell Parsons, Dallas independents.

On drillstem test in the Madison lime from 8360-500 ft, 40 gravity oil flowed at the rate of 40 bbl an hour. On a second, deeper test, 850 ft of oil and gas-cut mud were recovered and some free oil.

The Math Iverson well, whose ownership includes Viking Company and Tioga Petroleum Corporation, is on a line with 3 Amerada Petroleum wells, and all are on the Nesson Anticline.

Phillips Opens Oil Pool In Alberta, Canada

Phillips Petroleum Company has opened a new oil pool in Alberta, Canada, with completion of its No. 1 Movild, 30 miles southeast of Edmonton. The new well flowed 36 bbl of 38 gravity oil an hour, from perforations in the Viking sand at 3258-70 ft, and was shut in.

First Sparta Gas Well Drilled in Mississippi

Mississippi has its first commercial gas well from the Sparta zone. It is Austin E. Stewart et al's No. 1 McGehee in Adams County, which was drilled to 6515 ft, plugged back, and pipe set in the Wilcox-Sparta contact. Casing was perforated at 3001-03 ft, and the well gaged 1,500,000 ft of gas a day through a ¼-in. choke. On open flow the well was estimated as high as 20,000,000 cu ft a day. Stewart's associates are Jake Hamon, Dallas, and R. H. Alagood, Jackson.

North American Car Drills New Texas Oil Well

North American Car Corporation has announced that a new oil well in which it has a 50 per cent interest, has been brought in at Jack County, Texas. The new well test flowed at a rate in excess of 600 bbl per day through a 32/64-in. choke, and its gravity was higher than 40 API.

Named the W. T. Jones "A"-1, the new well is the first that North American has drilled in this particular area. The company expects, however, to start another test well on nearby acreage in less than 30 days.

Canadian Firm to Explore Williston Basin Area

Federated Petroleums Ltd., Calgary independent headed by R. A. Brown, Jr., has moved into the U. S. side of the big Williston Basin for its first major oil and gas exploration outside of its own province of Alberta.

The company, through a new wholly-owned U. S. subsidiary, is acquiring 400,000 acres of freehold and government leases, including 270,000 acres in eastern Montana, 120,000 acres in western North Dakota and 10,000 acres in northwest South Dakota. The lands are checkerboarded with the bulk of them lying between the Canadian border and Miles City, Montana, and stretching east from Miles City into the general Tioga area of North Dakota. It is through this belt that several important oil and gas discoveries have been made recently.

Robert A. Brown, Jr.

Federated plans a program of exploration that, coupled with cost of the leases, will cost more than a million dollars. Considerable geological work has already been done and will be followed up by a geophysical survey program. Information already gained on prospects for some of the new holdings indicate that first drilling can be initiated soon.

Federated Petroleums move into the U. S. Williston Basin play marks the first large-scale entry by a Canadian Independent oil company into this play under the recently authorized Foreign Exchange Control Board move under which Canadian oil and mining companies may secure funds for development programs in the United States.

Federated Petroleums is one of Alberta's oil pioneers. It made its start in the Turner Valley field near Calgary and more recently has shared in Redwater field development. Federated's production of oil in Alberta this year will be around 1,000,000 bbl, roughly 60 per cent from Turner Valley and 40 per cent from Redwater.

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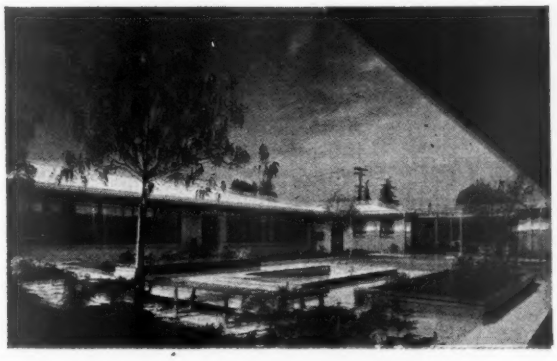

United's new spacious plant at Pasadena, California, affords the petroleum industry with extensive facilities devoted exclusively to geophysical purposes. Modern in every respect and containing the very latest in equipment, this plant was designed to provide the very finest possible world-wide geophysical exploration services.

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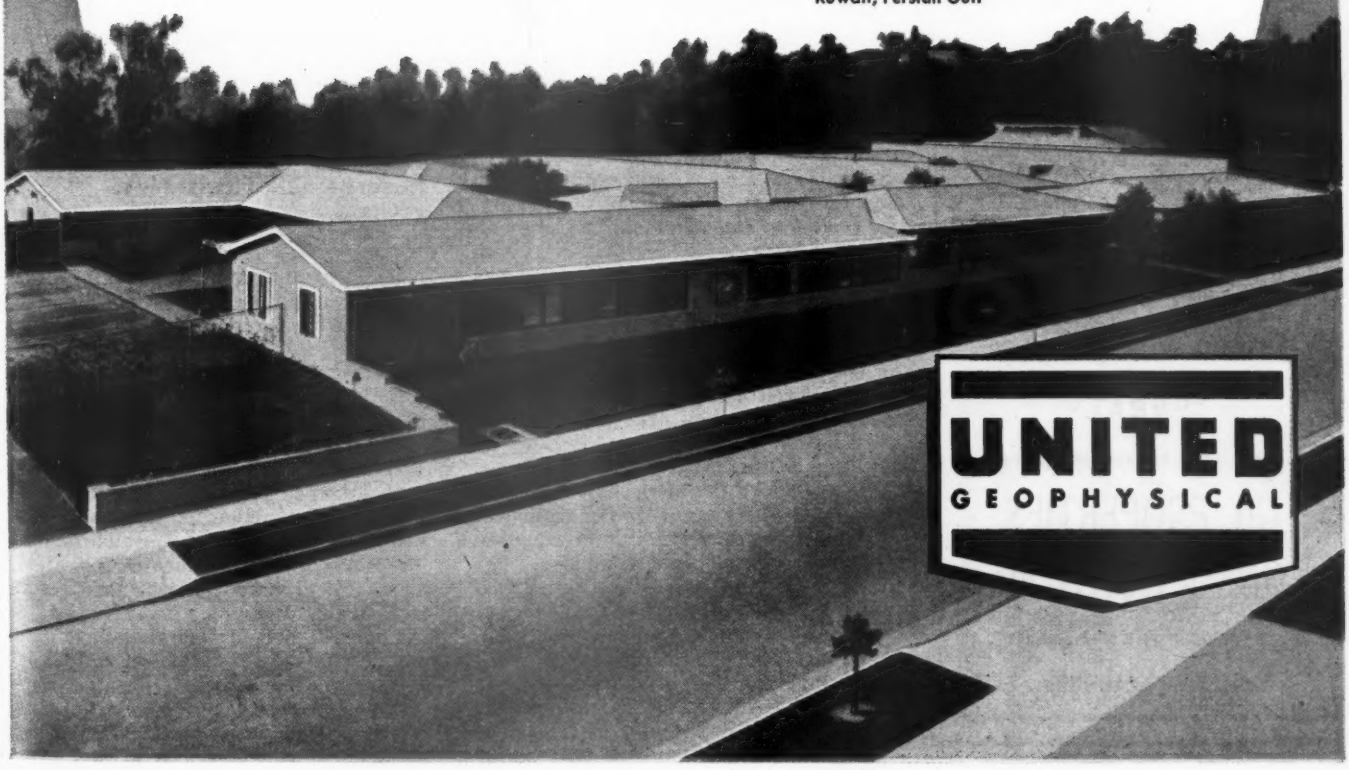

Ethiopian Drilling Site Chosen by Sinclair Oil

Sinclair Petroleum Company, Sinclair Petroleum Corporation's Ethiopian subsidiary, has selected a drilling site near the village of Galadi in the Ogaden, according to P. C. Spencer, president.

This selection of the location was made after slightly more than two years of intensive field operation, which included seismographic, gravity meter, and magnetometer surveys. Actual drilling operations are expected to begin early this year.

Carter Completes Well In Mesa Verde Formation

Carter Oil Company's No. 1 Unit, completed in the Mesa Verde formation, Uintah basin of Utah may be the forecast of broader development in the Rocky Mountain area. Carter's well recovered 270 ft of oil on test of the formation at 8176-95 ft, and was coring below 8269 ft. The wildcat is 30 miles southwest of a wildcat that recently found shows of gas in the same formation.

The Mesa Verde formation has not been given much attention in the Rockies before, although it is the main producing zone in the San Juan basin of New Mexico and Colorado. Discoveries in this formation have also recently been made in the Hells Hole area of Rio Blanco County, Colorado, and at Beaver Creek in Fremont County, Wyoming.

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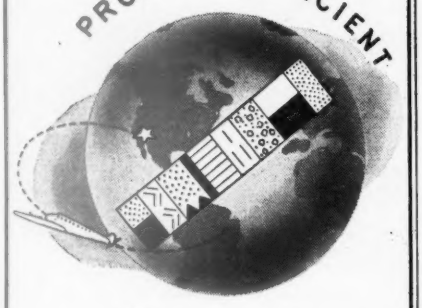

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Pasadena, California, plant of United Geophysical Company.

United Geophysical Builds Modern $750,000 Plant

United Geophysical Company's new, $750,000 plant at Pasadena, California, provides the industry with extensive facilities devoted exclusively to geophysical purposes. Designed in keeping with the way the organization works, the plant is laid out according to established production procedure, insuring a natural progression of functions. Each of the company's five divisions—research and development, engineering and supply, operations, interpretation and computation, and finance—is housed in separate buildings with a park-like setting extending around the various units, creating a quiet, attractive atmosphere.

The usual bottleneck encountered in development work has been removed by equipping both the research division and the engineering division with their own laboratories. Maximum development efficiency and flexibility have been assured by the building design, which provides movable walls in these divisions.

The Engineering and Supply Division is especially outfitted to take the equipment the research group has developed and supplies the production engineering, finished design, manufacturing and procurement facilities for field crews.

The service department, which handles procurement and supplies field crews with automotive and geophysical equipment occupies a large section of this division's building. The purchasing and supply groups have ample facilities for obtaining all of the supplies used in United's geophysical work and making arrangements for delivery anywhere.

Exploration Underway in East and West Pakistan

Drilling of core holes, northeast of Sylhet, Pakistan, began recently. Pakistan Petroleum Limited, who is carrying out intensive and extensive oil exploration and prospecting activities in East and West Pakistan will, for the first time since the birth of this country, drill a series of core holes, to a depth of 4000 ft each to obtain geological information on this area.

In Sylhet the older and possibly oil bearing beds are deeply buried beneath much younger and more recent rocks and it is therefore difficult to interpret the structure at depth.

The holes are being drilled by rotary system. In this system, the rock formation is penetrated by a rotating bit connected to a hollow drill pipe through which fluid is pumped to carry the rock cuttings to surface. These rock cuttings or cores afford the most convincing and satisfactory evidence of the geological horizon, providing valuable information about the oil and water content.

After drilling these core holes, Pakistan Petroleum will make an electrical survey of each hole to measure the electrical properties of the rocks penetrated. By comparing the survey results of all drilled holes it will be possible to estimate the dip of the underground beds of rock. This information will be of great value when a deep test well is drilled in this area.

According to Pakistan Petroleum's estimation it will take some six months to complete the work and obtain necessary information to plan the future program of drilling a deep test well.

Reserve Oil Finds New California Oil Area

Commercial production of wet gas from an heretofore untested zone on the company's property in Kern County, California, was reported recently by Reserve Oil and Gas Company.

The announcement explained that the Reserve-Pauley No. 58-33 well (Section 33 Township 11N Range 19W) produced at an estimated daily rate of 4,000,000 cu ft of wet gas through a 1/8-in. bean when tested between 4835 and 4893 ft. Production is from what is known as the Valve zone, which underlies other producing zones in this area. This is the first known test of the Valve zone in this area.

From the field it was explained that casing with shoe would be set at 4725 ft and the well completed. Results from current and previous formation tests indicate the well has a potential capacity of about 10,000,000 cu ft of wet gas.

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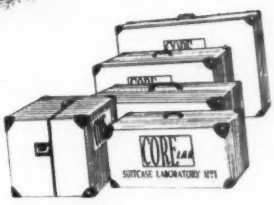
ON-LOCATION CORE ANALYSIS

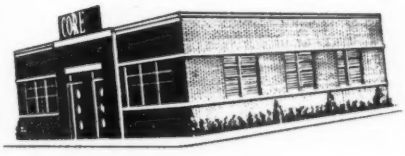
STATION WAGON CORE ANALYSIS



SUITCASE CORE ANALYSIS

FROZEN CORES

SIDE WALL CORE ANALYSIS

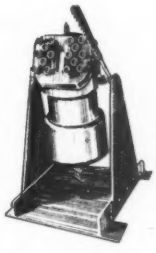


OFF-LOCATION CORE ANALYSIS

WELL LOGGING (on-shore)

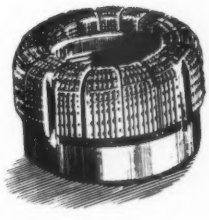
WELL LOGGING (off-shore)

WELL SAMPLING



RESERVOIR FLUID ANALYSIS

ENGINEERING STUDIES



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Los Angeles Oil Men Organize Exploration Firm

Thomas P. Pike, president of Thomas P. Pike Drilling Company, Los Angeles, announces the formation of a petroleum exploration organization known as the Christopher Oil Company.

The managing partners are: Thomas P. Pike, Stanwood I. Williams, and H. G. Haney, all executives of Thomas P. Pike Drilling Company. With a group of other California investors, they have subscribed the entire capital of the company and are proceeding at once with the first of a series of exploration projects in West Texas.

Offices are being maintained in Los Angeles and in Midland, Texas.

All of the managing partners have been engaged in the oil business for the past 20 years; and have been owner executives of Thomas P. Pike Drilling Company for the past 14 years.

Skelly Well Extends Logansport Oil Field

The Logansport field of DeSoto Parish, Louisiana, has been extended more than 3 miles with completion of Skelly Oil Company's No. 1 Blunt. The new well flowed an estimated 12,000,000 cu ft of gas daily from 7 sets of perforations in the Paluxy sand at 2870-3058 ft. Flow was through a 3/8-in. choke. Plugged back total depth is 3454 ft, with 5½ in. casing cemented at 3254 ft.

Texaco Well Completed

The Texas Company has opened a new oil pool at its No. 1 Chapman well, near Mannsville in Bryan County, Texas. Drilled in the Arbuckle, limestone at 3084 ft, the hole was plugged back to the Bromide sand at 924-950 ft, and the well completed for 112 bbl of 43-gravity oil a day through a 13/64-in. choke.

Spraberry Trend May Cover Midland County

The Texas Company has completed its No. 1-B-NCT-2 C. Schrarbauer, in Midland County, Texas, causing geologists to think that the Spraberry might extend from the eastern to the westernmost borders of the county. The new well was completed for a daily pumping potential of 44.17 bbl of 33.6 gravity oil, 49.2 per cent water, with gas-oil ratio of 79-1. It is 12½ miles west of production in the Tex Harvey-Spraberry field. The new well produces from open hole section between 7688 ft, where 7⅝-in. casing is cemented and 8050 ft.

Flynn Oil Gets Producer In Anadarko Basin

Flynn Oil Company's No. 1 School Land in Beaver County, Oklahoma, has opened the first crude oil production in the northwest sector of the Anadarko Basin in the Oklahoma Panhandle region. Total depth of the new well is 5549 ft. With 7-in. casing set at 5540 ft, the well swabbed 162 bbl of 38.9 gravity crude oil, without any water, in 8 hours through casing. With the oil is 250,000 cu ft of gas a day. It has not definitely been determined as yet what formation it is producing from, but it is believed to be a reef formation.

Texaco Drills Well in Garvin County, Oklahoma

A new well in Garvin County, Oklahoma, has been brought in by The Texas Company. It is the No. 1 Degraffenreid-Dobyns Unit, which has a plugged back depth of 7544 ft. The new well flowed 370 bbl of oil, without any water, in 23 hours, through a ¼-in. choke. Later it flowed 327 bbl of oil, without water, in 22 hours through a ¼-in. choke. Gas-oil ratio was 1820 to 1.

Davidor and Davidor Are Completing Discovery Well

Davidor and Davidor has opened the Gilcrease Southwest oil pool with completion of its No. 1 Leslie Rogers. Drilled to a depth of 3999 ft, the well is producing at the rate of 40 bbl per day from the Misener sand zone, at the base of the Woodford formation. Deeper possibilities of the Hunton or Wilcox formations have not been explored at the new well, but a well offsetting this to the west operated by Beach and Talbot of Tulsa is expected to be carried to the Wilcox, Davidor and Davidor geologist, Karl L. Wehmeyer reports.

Area of the well, called the Southwest Brownsville, was situated on a combination seismograph-subsurface high.

Nigeria Test Well Reaches Depth of 4500 Ft

The Anglo-Iranian Oil Company Newsletter has reported that the test well near Owerri, Nigeria, has reached a depth of 4560 ft, after two months' drilling. Work is being carried on by the Shell-D'Arcy Petroleum Company of Nigeria, in which Shell and the D'Arcy Exploration Company (the prospecting subsidiary of the AIOC) each have 50 per cent interest.

Drilling of this first test well follows extensive surveys that began back in 1937, and have gone ahead after the war years. Much territory remains to be surveyed, and it will probably be some time before the possibilities of commercial oil production are known.

Gulf Plans Wildcat for Off-Shore Alabama Area

The first wildcat to be drilled in the offshore regions of Mobile Bay, Georgia, has been spudded in by Gulf Refining Company. The test is the State of Alabama No. D-1, and is situated approximately 22 miles south of Mobile and about 8 miles northeast of the mouth of the Bay. It is scheduled to go to 10,000 ft.

New California Field Open

A new field has been discovered in Los Angeles County, California, about 2 miles northwest of the Honor Rancho oil field, with completion of the No. 1 Rynne-Fisher. The well, drilled by Ted Sterling, operator, was completed flowing at an estimated rate of around 5000 bbl a day of 32-deg gravity clean oil. A week later, the flow was restricted to about 200 bbl a day of 33-deg gravity clean oil. Production is coming from formations between 4610 and 4724 ft.

New Mexico Discovery Made

A Lea County, New Mexico, discovery has been made in the Wolfcamp region by Forest Oil Corporation, Houston Oil Company, and Gulf Oil Corporation. It is the companies' No. 1 H. L. Lowe, which was completed for a 24-hour flowing potential of 385 bbl of 38.2 gravity oil. The well was flowing through ½-in. tubing, with perforations between 10,126 and 10,136 ft. Gas-oil ratio was 734.1.

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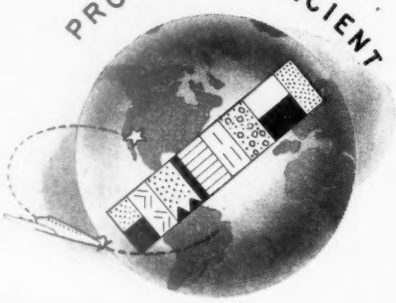

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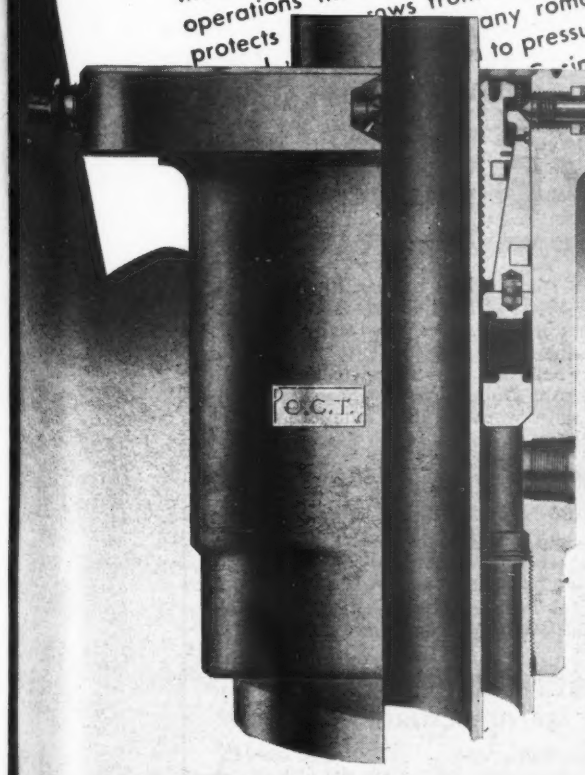

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Patharia Hills Test Is Carried to 5000 Ft

Pakistan Petroleum Limited's oil well in the Patharia hills has now been drilled to a depth of 5000 ft and is approaching its final objective. High pressures have made drilling difficult, and a drilling fluid weighing 115 lb to the cubic feet, nearly twice as heavy as water, has had to be used to continue drilling.

The hole was lined twice by strings of steel casing cemented to hold back the rocks drilled through and permit drilling to be carried deeper. The first occasion was at 2355 ft, where 10¾ in. diameter casing was cemented. The second casing was of 7 in. diameter, which was cemented at 3813 ft.

Numerous signs of gas have been encountered and have been given short tests that showed the gas to be under considerable pressure. Analyses of gas samples show them to be "dry" suggesting that the gas is not associated with oil.

Only poor oil shows have so far been met and results to date have been disappointing. Tests of the oil shows will be carried out shortly, however, which will give definite evidence of the value of the sands.

Drilling operations in Patharia were inaugurated by His Excellency the Governor of East Pakistan.

Stephens Finds Oil At 1000 Ft Depth

Stephens Petroleum Company has a new shallow well at its No. 1 Stewart in the Doyle Pool of Stephens County, Oklahoma. The well which was begun as a test to 1500 ft, ran 40-minute drillstem test at 1022-43 ft, showing gas in two minutes at 250,000 cu ft daily. It made a spray of oil in 22 minutes, and recovered 325 ft of clean oil and 10 ft of oil-cut mud. It was drilled to a total depth of 1050 ft, and 5½-in. casing was landed at 1048 ft.

New Well Completed in Mallard Bay Oil Field

The Mallard Bay field of Cameron Parish, Louisiana, was given another well recently when the Martex Realization Corporation DeGolyer and MacNaughton A. S. White No. 2 well was completed. The well flowed 218 bbl of 42.6 gravity condensate and 7,680,000 cu ft of gas through a ¼-in. choke. DeGolyer and MacNaughton engineers estimate the well at 102,000,000 cu ft of gas a day on open flow.

Test Set for Louisiana

A deep Miocene sand test for Terrebonne, Parish, Louisiana, was announced today by Cities Service Oil Company (Delaware). The projected 11,700-ft wildcat is situated on a 1700-acre block owned by Forest Oil Corporation and Cities Service. Cities Service will be the operator. The test is Delta No. 1, in the center. Nearest production to the test is the Lake Long field, four miles to the southeast. The Houma pool is 4½ miles west of the wildcat.

New Oklahoma Oil Pool

Surrounded on all sides by dry holes, the Flynn Oil Company's No. 1 Wiley in Lincoln County, Oklahoma, has been completed. Discovery well of the Rossville Southwell pool, the No. 1 Wiley is producing from the Skinner sand at 4780 ft for initial production of 60 bbl a day. Geology in this area has been described as a stratigraphic trap.

Bishop Drills Kansas Well

Bishop Oil Company has brought in a second well on its 40-acre Petrowski lease in the Carmi oilfield of Pratt County, Kansas. The well produced 89 bbl of 40 gravity crude flowing through tubing on a 3-hour test. It was drilled to a total depth of 4307 ft.

California Oil Search Gets Underway

Douglas Oil Company of California is prepared to spud in a well on its lease in the Castaic Hills, California, area as soon as any one of several wells now being drilled on adjacent properties comes into production.

Operations in this field are being watched with considerable interest as drillers were believed to be approaching the producing zone. The first well in the area was brought in September 15 by Continental at 500 bbl a day of 31-32 gravity oil. This well is 3000 ft from the Douglas lease.

The Texas Company's Honor Rancho No. 2 was reported to be down 5144 ft drilling through hard sand, with the producing zone estimated to lie at 5500 to 5700 ft.

Richfield's Golden well, and the George Terry well, 595 ft north and 100 ft east of the Douglas lease, are drilling. Both of these wells were expected to hit the producing zone soon.

Shell Completes Utah Well

Shell Oil Company is completing its No. 1 unit in San Juan County, Utah, where the wildcat has been showing for both high gravity oil and carbon dioxide gas. The well was drilled to 8762 ft and pipe was set at 7680 ft. It gaged 34.3 bbl of 53.7 gravity oil through perforations in the Mississippian at 7520-36 ft. There also was a slight salt water cutting.

Kansas Wildcat Set

A 3800-ft test for Norton County, Kansas has been announced by Cities Service Oil Company (Delaware). The wildcat is the Fredde No. 1, on a block held by Cities Service, Phillips, Skelly, and Sunray. It is six miles northwest of the one-well Houston pool. Cities Service will be the operator.

Blackwell Drills Discovery

The Blackwell Oil and Gas Company of Cushing, Oklahoma, has completed a discovery well in Payne County, Oklahoma. Its No. 1 Gerrish made a completion flow of 7 bbl of oil per hour through a 15/64-in. choke. The well was bottomed at 5238 ft, and 7-in. casing was on top of the Wilcox sand at 5205 ft.

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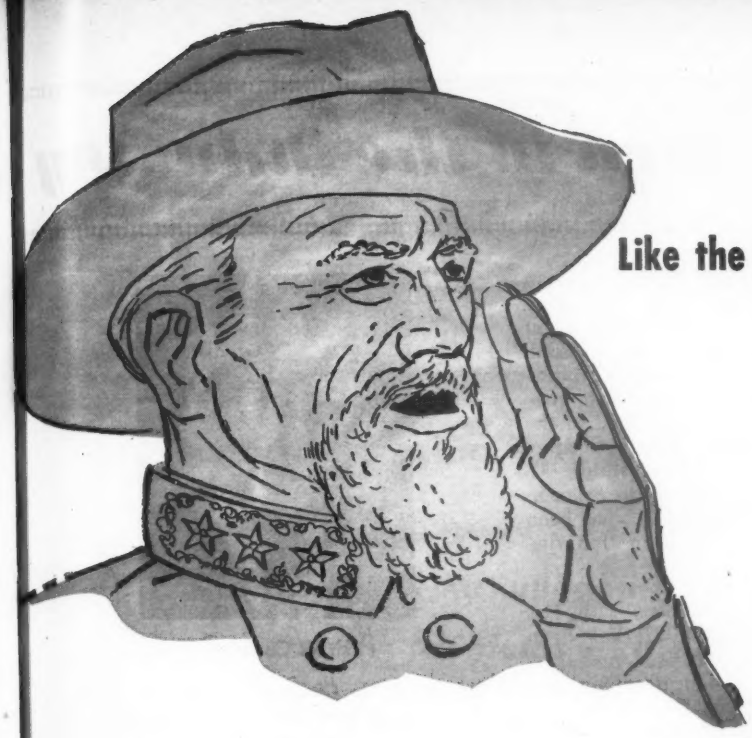

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W. T. Powell

William T. Powell has been elected executive vice president of Emsco Derrick and Equipment Company, a new position created by Emsco's Board of Directors. Powell has been with Emsco 14 years and has been vice president, nine years.

W. T. Bill Payne, head of Big Chief Drilling Company, Oklahoma City, has been elected president of the general Mid-Continent Oil and Gas Association. He succeeds Jake L. Hamon, Dallas. Payne has been vice president, and prior to that, chairman of the Kansas-Oklahoma division of the association. In his new position he will represent the southwestern industry on several federal agency advisory committees.

J. V. Wicklund has been named president of Michigan Oil and Gas Association, which elected its 1951-52 officers recently. Wicklund succeeds **I. W. Hartman.** Other officers are: **T. Glenn Coley,** vice president, **William Palmer,** executive secretary; **Kurt de Cousser,** cotreasurer; and **O. H. Kristofferson,** cotreasurer.

A. H. Bell has been named national vice president of the California chapter of the American Association of Oilwell Drilling Contractors. Elections were held at a regular meeting in Bakersfield, California.

Officers include: **E. C. Brown,** chairman; **Carl Gates,** vice chairman, Los Angeles Basin, **M. V. Stansbury,** San Joaquin Valley; **Charles Reiman,** secretary.

Thurman Pinkerton, formerly a petroleum engineer in Magnolia's Gulf Coast division office at Houston, Texas, has been transferred to the Cushing producing district with headquarters at Drumright, Oklahoma. **Robert K. James,** petroleum engineer at Lake Charles, Louisiana, has been transferred to the Gulf Coast division offices at Houston. **Warren D. Phelps,** petroleum engineer in the Cushing district, has been transferred to the Oklahoma division offices at Oklahoma City. **Mertz Ratliff** has been promoted to construction foreman in Magnolia's Kermit, Texas, producing district. **Clarence E. Rabb,** assistant foreman in Magnolia Petroleum Company's Shreveport, Louisiana, producing district, has been promoted to production foreman and transferred to the company's Brownfield, Texas, producing district in West Texas. **Ralph M. Cummins,** formerly assistant foreman in the Kermit producing district, has been made production foreman in that district.

R. T. Harris, who has been with The Texas Company since 1927, has been promoted to assistant to manager, Rocky Mountain division, producing department.

Harris, division accountant with offices at Denver, will be succeeded by **R. M. Harris,** assistant division accountant, on the same date.

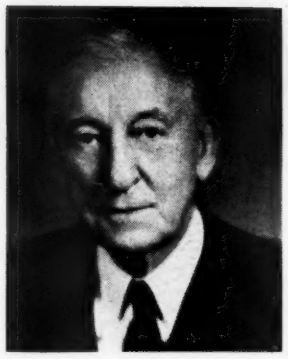
R. T. Harris, a native of Bowling Green, Kentucky, was graduated from the University of Texas with the B.B.A. degree in business administration. He joined the company as a clerk in the Houston accounting office, producing department, in 1927, where he rose to assistant division accountant in the Louisiana-Arkansas division in 1933. He was named division accountant in 1945.

R. M. Harris was graduated from Mississippi College with the B.A. degree in 1936 and from Louisiana State University with the M.A. degree in business administration two years later. His first job with the company was that of clerk at Shreveport in 1938. Transferred to the Rocky Mountain Division in 1946, he was made head disbursement clerk and, in 1947, assistant division accountant.

J. E. McCleary

John E. McCleary has been appointed assistant manager of the crude oil department of Humble Oil and Refining Company. He received his bachelor's degree in business administration from the University of Oklahoma in 1932, joining Humble in 1936.

During World War II he served as a captain in the Quartermaster Corps for four years.



H. M. Cosgrove

Harold M. Cosgrove of Tulsa, Oklahoma, was presented with a plaque for outstanding service by the Nomads at their annual meeting held recently in Chicago, Illinois. Cosgrove has been executive secretary of the Nomads for a number of years.

Donald M. Davis has been named exploration manager in the Gulf Coast producing division in Houston, Texas, for Pure Oil Company. **Karl A. Mygdal** is chief of the development geological section in Chicago, Illinois. Rapid increase in Pure Oil exploration activities brought about the creation of the two posts of assistants to the exploration managers. Davis has been with Pure for 24 years and Mygdal 13.

Lee Cornell, Franco Central Oil Company, was recently elected president of the Kansas Geological Society for 1952. Other officers include: **William M. Brodrick,** Anderson-Prichard Oil Corporation, vice president; **Brian Kirby,** Sunray Oil, secretary-treasurer, and **George Reed,** Nadel and Gussman, member of the board. **Ralph Ruwwe,** Stanolind Oil and Gas, in the retiring president.

DEATHS

Erik Uno Garpner, former Tulsa geophysicist died at his home in Los Angeles, California, recently. He was formerly employed with the Dixie Oil Company, Stanolind Oil and Gas Company, Frost Geophysical Company, Reed Magnetic Surveys, United Geophysical Corporation, and Seismograph Service. He was last employed with Seismograph as a party chief of a gravity meter crew until he resigned late in September.

W. B. Ferguson, who was given credit for discovery of the Clay Creek oil field north of Brenham, Texas, died recently in Brenham. A native of West Virginia, Ferguson made his home in Brenham in 1925 as a geologist for Sun Oil Company. An independent geologist, Ferguson was also engaged in development of a soil analysis process for locating petroleum deposits.

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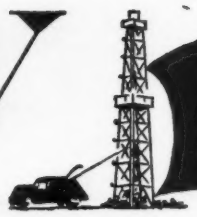

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Excerpts From Latest Job Reports—McCullough Tool Company

PROBLEM	SOLUTION	RESULT
1. **Mt. Holley, Arkansas.** 5½" 17# cemented casing had a dog leg above zone to be perforated. Solid perforators could not pass kink.	McCullough Glass Jet Perforator with Flexible Steel Strip Carrier successfully passed bad spot perforating desired zone.	Oil operator reported very satisfactory production.
2. **Edmonton, Canada.** 200' of 10¾" surface casing parted from the main string, settled at an angle, resisted all corrective measures. Abandoning seemed necessary.	McCullough Bottom Hole Jet Cutter was arranged to make a flare at the top of the casing that had been dropped.	Flare acted as an adaptor, permitting the bit to pass without hanging up. Well was saved and completed without further trouble from this source.
3. **Los Angeles, California.** Major operator wanted to speed-up setting of bridging plugs. He had formerly dumped in cement, let it set, then tested it on the pump for several days.	a. McCullough Type 'B"' Expandable Bridging Plug was set in the well on an electric wire line. b. McCullough Gun Tester was used to test the plug.	Several days of rig time were saved over former methods. Bridging plug was later drilled up with a used rock bit in the usual time of 30 minutes.
4. **Ely, Nevada.** Drill pipe was stuck and the McCullough Back-Off Service was called to back-off the pipe at the drill collars.	Operator agreed to have the McCullough Magna-Tector run first to find out EXACTLY where the pipe was stuck.	Magna-Tector indicated that only the bit was stuck and after working all the pipe was freed eliminating costly fishing.
5. **Long Beach, California.** Salvage operator purchased well from major oil company for salvage and abandonment. But decided to run a gamma ray log first.	McCullough Radiation Well Logger located new producing zone that had been missed completely during other logging operations.	After perforating with McCullough Burrless Bullets, this well produced 200 B/D.
6. **Victoria, Texas.** Other wells in same area had been tested to flow from 200# to 800# on 9/64" choke. Operator wanted better perforations and a better well.	12 McCullough Burrless Bullets were shot through the 5½" 17 # casing in a two foot zone.	During test well came in immediately, flowing a 2" stream of pipe line oil at 880# pressure on ¼" choke.
7. **Brea Canyon, California.** Operator had been informed that it was impossible to back-off a joint below the bumper sub, the bore of which was only 1⅛".	McCullough arranged a short String Shot with a special sinker bar for the purpose.	Back-off job completed although it was thought impossible to do.
8. **Huntington Beach, Calif.** Drill pipe had to be backed-off in a well 74° off vertical.	McCullough Jet Back-Off Tool reached desired joint and was fired.	All free pipe was recovered in one undamaged section.
9. **Houston, Texas.** Salvage operator wanted to speed-up removal of casing from abandoned well. Former methods required several days, sometimes several weeks.	a. McCullough Magna-Tector quickly located the exact stuck point. b. McCullough Jet Casing Cutter instantly severed casing above stuck point.	Time required One hour and fifteen minutes. (Including rigging up and removing equipment.)
10. **Wyoming Wildcat.** Production of 60 B/D below expectation of this operator.	Well was re-perforated with McCullough Glass Jet Perforator and Flexible Steel Strip Carrier.	After perforating production increased from 60 B/D to 300 B/D.

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To obtain more information on products advertised see page E-41

▶ **G. J. Smith,** superintendent of the exploration department and **E. V. Hewitt,** general superintendent, Pan American Production Company, have been elected vice presidents. **A. W. Lott,** administrative assistant, has been elected assistant secretary of the production company and the Pan American Gas Company.

Smith began his oil career when he entered the service of The California Company after graduating from the University of Minnesota in 1925, and after varying lengths of service with other major oil companies, joined Pan American in 1936 as a geologist, advancing through various positions in the company to that of superintendent of its exploration activities.

Hewitt entered the petroleum industry in 1921, after attending the University of Michigan, as a district superintendent for the Michigan Petroleum Corporation. He was later employed in various engineering and operating capacities by two other large oil industry firms until he joined Pan American in 1935 as a field foreman. In 1937 he was promoted to assistant general superintendent and in October 1938 became general superintendent in charge of drilling and production operations.

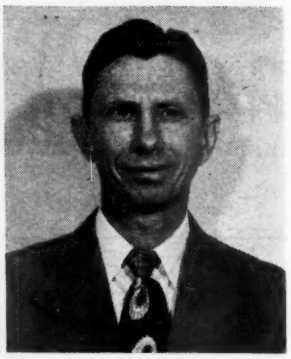
Ben H. Martin, heretofore West Texas district geologist at Abilene, Texas, comes to Houston as superintendent of the exploration department, succeeding Smith.

Martin was graduated from Lafayette College in Easton, Pennsylvania, in 1934 with his degree in mining engineering. He came to Texas immediately and entered the employ of a major oil company as a geological scout. After 10 years of experience with other companies he joined Pan American early in 1941 as a district geologist, and took over the supervision of the company's West Texas geological activities in July, 1946.

John L. Hoyt, Jr., assistant general superintendent, has been promoted to general superintendent, succeeding Hewitt. Hoyt graduated from Louisiana State University with a Bachelors degree in petroleum engineering in 1938 and immediately entered the service of Pan American as a roustabout. He was appointed assistant general superintendent in October, 1948.

G. J. Smith

E. V. Hewitt



M. A. Sparks

Duval A. Davidson, Jr., heretofore superintendent of the Valley district with headquarters in the Willamar field, Willacy County, Texas, has been promoted to assistant general superintendent with headquarters in Houston. Davidson received his degree in petroleum engineering at Texas A and M College in 1939 and in November of that year was employed by Pan American as roustabout. After some eight years service in various engineering and operating capacities he was appointed a district superintendent in October, 1948.

William B. Rodan, geologist in the Abilene office has been promoted to senior geologist and will be in charge of West Texas geological activities, retaining his headquarters in the Abilene, Texas, office. Rodan received his degree in geology at the University of Texas in 1942, and entered the employ of Pan American in April, 1946.

▶ **Merle A. Sparks,** who recently returned from service with the Petroleum Administration for Defense in Washington, D. C., has been named coordinator of joint operations in Sun Oil Company's southwest producing division. This is a newly created position in the Southwest Division's operating department. He will continue to make his headquarters in the Dallas office, where he was a senior petroleum engineer before leaving for Washington last spring on his six-months leave of absence.

In Washington, he was an assistant to the director of the Production Division, office of the director of Petroleum Administration for Defense. Before going to the PAD position, Sparks' only interruption in his 23-year career with Sun was for five years of military service in World War II.

Sparks started with Sun in the Oklahoma division in 1928, after studying mechanical engineering at the University of Oklahoma. He was transferred to the Southwest Division in 1938.

He was working in Corpus Christi and Beeville area when called to World War II service. On his return to Sun in April of 1946, he was assigned to the Dallas Office.

Nomads Annual Luncheon. Ed Lorehn, Houston, Texas, chairman of the National Board of Regents of the Nomads was master of ceremonies and Jack Berlin of Standard Vacuum of New York was the main speaker for the Nomads' meeting in the main ballroom of the Blackstone Hotel in Chicago, Illinois during the recent API convention. Presidents and past-presidents who attended were Fred Ripley and Ted Sutter, Los Angeles; H. B. Book, New York; H. M. Cooley, Tulsa; C. B. McDonald, Houston; Jerry Engstrand, Los Angeles; Courtney Berlin, Dallas; Jack Berlin, New York; A. J. Olson, Dallas; Ken Demarest, New York; E. L. Lorehn, Ray L. Dudley, R. G. Hamaker, Harry Estes, Tom W. Nelson, and Wayne Rives, Houston.

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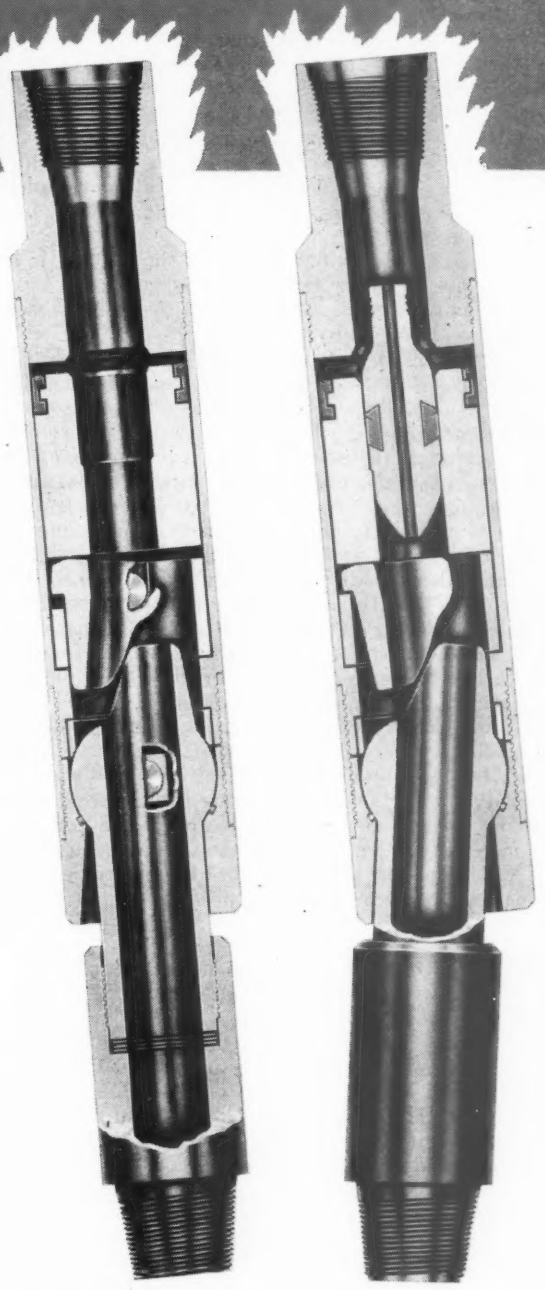

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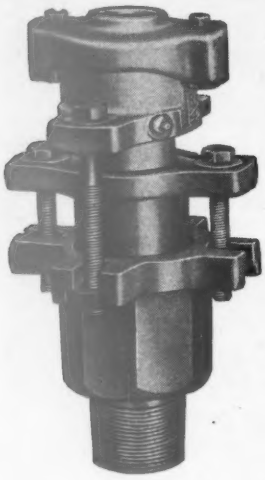

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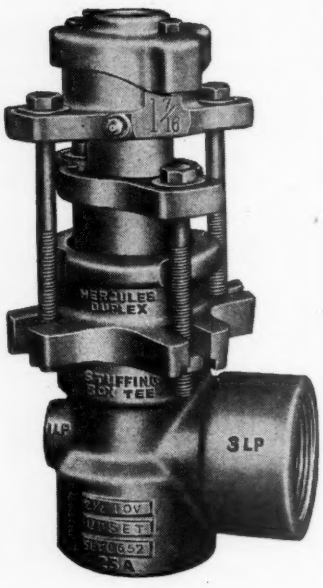

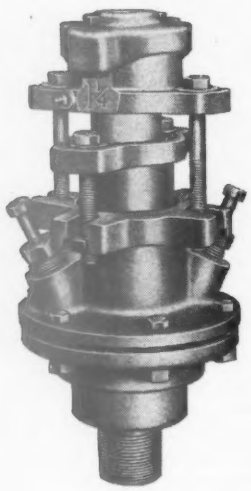

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▸ **George H. Galloway** has been named assistant chief geologist—programs for Stanolind Oil and Gas Company in the Tulsa general office. **E. W. Price** succeeds Galloway as division geologist for the central division, with offices in Oklahoma City. **E. L. Selk** replaces Price as district geologist for the Oklahoma district. Selk will also be stationed in Oklahoma City.

William S. McCabe assumes a new title, regional geologist for the Rocky Mountain Division and Canada. **John C. Johnston** succeeds McCabe as division exploration superintendent, and **Ross W. Craig** becomes division geologist replacing Johnston. All three will be in Casper, Wyoming.

In the North Texas-New Mexico Division at Fort Worth, **Russell Farmer** has been promoted to division consulting geologist, and **Thomas A. Hendricks** to division geologist.

Galloway joined Stanolind in 1943 as a senior geologist in Tulsa. For three years he was district geologist for the Oklahoma district, and in 1948 he became division geologist for the central division. He was graduated from the University of Nebraska in 1939.

Price has been with the company since 1936. He became district geologist for the Oklahoma district three years ago. He is a graduate of Wichita University with a BA in geology.

Selk is also a University of Nebraska graduate. In 1934 he joined Stanolind, transferring to the geological department in 1936. McCabe, the new regional geologist for the Rocky Mountain division and Canada, went to work for Stanolind in 1943 as district geologist in Casper, and became division exploration superintendent in 1949. He was graduated from the University of Illinois and also did graduate work in geology at Princeton.

Johnston, who succeeds McCabe, received BA and MA degrees in geology from the University of Wyoming. He was employed by Stanolind in Shawnee, Oklahoma, in 1940.

Craig, the new division geologist, has worked for Stanolind since 1944. Shortly after joining the company, he was sent to Casper to do surface geological work, and has been assistant division geologist for the Canadian division for the last year. Craig is a graduate of the University of Virginia.

Farmer, the new consulting geologist for the North Texas-New Mexico division in Fort Worth, holds BA and MA degrees in geology from the University of Missouri. He first went to work for Stanolind in 1937. Hendricks, who succeeds Farmer, joined Stanolind in 1948 following a long period of service with the U. S. Geological Survey. He has a BS degree in geology from Northwestern University and an MS. from the University of Colorado. He is a member of the Geological Society of America, American Association of Petroleum Geologists, Society of Economic Geologists, and local geological societies.

▸ **Paul A. Kindsvater** has been named district superintendent of the newly created West Texas district with offices in Midland, Texas, by the British-American Oil Producing Company. He was formerly field superintendent in charge of the East Texas fields, having his headquarters in Selman City, Texas. Kindsvater joined British-American in 1941 as a roustabout in the Oklahoma City field, acquiring additional oil field experience during the intervening years by working as a pumper, engineer, district engineer, and district foreman.

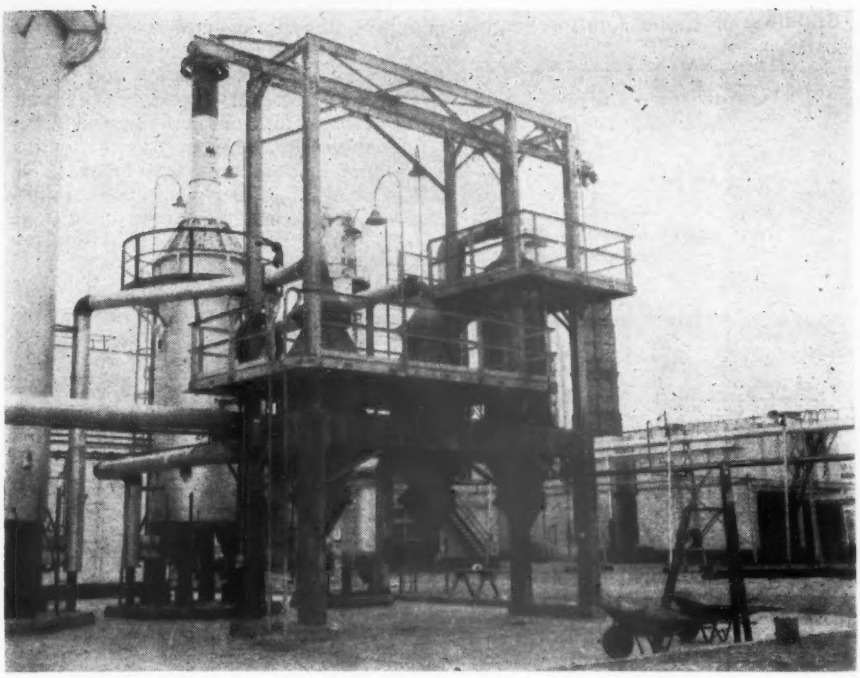
A district production office building is undergoing construction at the present time in Midland.

Fred A. Norris, former district engineer stationed in Seymour, Texas, has been promoted to district superintendent of the central district, filling the vacancy left by the death of J. C. Bruce. Headquarters for the central district are in Oklahoma City and the territory covered includes Oklahoma, Kansas, Illinois, and parts of New Mexico.

Norris has been with B-A since 1944, having been district engineer in Oklahoma City from 1946 until his transfer to Seymour in 1950.

▸ **Earl G. Watkins,** Oklahoma City, and **Marion L. Kimmel,** Flint, Michigan, have been given Humble Oil and Refining Company fellowships in petroleum engineering for the 1951-52 school year. Watkins attends the University of Oklahoma and Kimmel is a student of Louisiana State University.

Each fellowship provides $1250 for the school year, with an additional $300 for tuition, fees, equipment, and supplies. The two fellowships are among several offered by the company to aid higher levels of learning in science and engineering.



Three-stage contact with the catalyst, with between-stage reheating, is typical of the Platforming process, as shown by these three reaction chambers at Premier's Fort Worth refinery. The three-stage heaters are in the background.

Catalytic Reforming Rebuilds Hydrocarbons

ARCH L. FOSTER*

WITH 86 catalytic reforming units operating, building, or under contract the refining industry's revamping program for natural hydrocarbons is assuming huge proportions. As the situation stands now catalytic reforming is in the center of the refining development spotlight and offers more relief to the hardpressed refiner who needs more octane numbers and higher vapor pressures than he can obtain by his already installed methods. And with the rated capacity total of nearly 400,000 bbl of charge stock per day, prospects for competitive motor fuels and for additions to aviation fuel supplies are "looking up".

Understandably enough, catalytic reforming developments followed catalytic cracking advances. Catalytic cracking produces motor fuel where no motor fuel, as the world knows it, existed before. Therefore catalytic cracking increases the total available supply of fuel, of gasoline vapor pressure, and octane rating. Catalytic reforming adds little to the total volume of hydrocarbons of motor fuel boiling range; it is true that heavy naphtha, of too low vapor pressure for desirable motor fuel 'as is,' can be converted to higher vapor pressure suitable for inclusion in motor fuel on that basis. Similarly, naphtha of any vapor pressure or boiling range that is composed largely of straight-chain hydrocarbons of low octane rating is molecularly rearranged to yield much higher anti-knock quality material that can be included in motor fuel where it could not be so used in its natural state.

The primary purpose of reforming is not to increase volume of motor fuel but largely to raise its qualities in those items that are most important as motor fuel. Corollary to this is the production of large amounts of aromatics, benzene, toluene, xylenes, and others.

Catalytic reforming is not new nor peculiar to the postwar industry. The first commercial installations utilizing catalysts for improvement of naphtha fractions were the half-dozen hydroforming process units built by Kellogg before World War II. These units employed the fixed bed principle, regenerating the molybdenum-containing catalyst in beds alternately with passage of vapors to be reformed, vapors with which are combined hydrogen-bearing gases. These units produced large amounts of aromatics under the peculiar influence of the catalyst and our first major source of aromatics outside of coal tar was the hydroformate from these units. More recently the fluid catalyst principle, employed first commercially in the catalytic cracking process designated by that expression, is being applied to hydroforming and at least four American units designed under this system are being built.

During the War (II) the Cycloversion process was developed by Phillips' research department and has been built in a total of 46 units, as a naphtha reformer and desulfurizer method, by refiners, again searching for means to improve both TEL susceptibility by removing sulfur, and octane rating by molecular rearrangement.

Following the war's end Universal Oil Products Company's Platforming process was developed in pilot plant experimental work and the first large-scale unit was built at Old Dutch Refining Company's plant in Muskegon, Michigan. For more than a year this unit was operated essentially as an experimental unit, albeit producing commercial quantities of high octane number motor fuel component from the decidedly low-grade Michigan straightrun naphtha. With these results as basis for design the process has been adopted by refiners until now a total of 25 units, with a combined capacity of 102,400 bbl of charge naphtha per day, are operating, building, or under contract.

More recently Socony-Vacuum Oil Company's development department has announced a catalytic reforming process, and is building at least one unit that will be, doubtless, in the nature of a commercial-sized test unit. Similarly, Atlantic Refining Company has brought out a catalytic reforming process, and two units are being built or are contracted for, utilizing this method of reforming.

The Houdriforming process was developed by Houdry researchers, and appears to employ somewhat different conditions, such as pressure but the general routine of treatment is similar to that of other processes mentioned. At least two units are scheduled to be built soon under this process.

All these processes have similarity in purpose, and give many of the same reactions. All are desulfurizing systems, removing organic sulfur in quantitative proportions. The advantages of sulfur removal are so well known as to require little discussion. Low sulfur content means higher tetraethyllead susceptibility, that is, a greater increase in octane rating for each unit if 'lead' is added.

All the processes decompose hydrocarbons already in the motor fuel boiling range — charge stocks often have 450-475 F. endpoints — and rearrange their molecular configurations into those

*Editor, Refining and Gas Processing.

EXCLUSIVE

List of Catalytic Reforming Units, Operating, Building, or Under Contract, as of December 15, 1951

Platforming Units

Licensee	Location	Design capacity B/SD
Old Dutch Refining Co.	Muskegon, Mich.	1,500
Johnson Oil & Refining Co.	Cleveland, Okla.	1,843
Kendall Refining Co.	Bradford, Pa.	1,500
Bell Oil & Gas Co.	Grandfield, Okla.	1,500
Aurora Gasoline Co.	Detroit, Mich.	4,500
Premier Oil Refining Co.	Ft. Worth, Tex.	1,500
Mid-West Refineries, Inc.	Alma, Mich.	1,500
Taylor Mayfair Properties	Port Isabel, Tex.	4,000
Petroleum Specialties, Inc.	Flat Rock, Mich.	900
Bitumen & Oil Refineries	Matraville, N.S.W.	1,500
Standard Oil of Calif.	El Segundo, Calif.	12,100*
Canadian Oil Refineries	Froomfield, Ont.	3,800
Shell Oil Co. Inc.	Houston, Tex.	16,000*
Cosden Petroleum Corp.	Big Spring, Tex.	4,320*
Shell Oil Co. Inc.	Wood River, Ill.	3,400*
Atlas Processing Co.	Shreveport, La.	4,400
Skelly Oil Co.	Longview, Tex.	1,850
Anglo-Iranian Oil Co. Ltd.	Llandarcy, Wales	6,000
Eastern States Pet. Co. Inc.	Houston, Tex	4,500*
Roosevelt Oil & Ref. Corp.	Mt. Pleasant, Mich.	1,800*
Elk Refining Co.	Falling Rock, W. Va.	1,500
Great Southern Chem. Corp.	Corpus Christi, Tex.	4,000*
Continental Oil Co.	Lake Charles, La.	6,000*
Sun Oil Co.	Toledo, Ohio	11,000
Wilcox Oil Co.	Bristow, Okla.	1,500
Total, 25 units		102,413

* Aromatics

Perco Cycloversion Units

In Operation

Company	Location	Bbl/day Capacity
Barsco Oil Co.	Wichita, Kan.	4,000
Continental Oil Co.	Artesia, New Mexico	1,000
Evangeline Refining Co.	Jennings, La.	400
Gladewater Refining Co.	Gladewater, Tex.	600
Inland Refining Co.	Palestine, Tex.	700
Kanotex Refining Co.	Arkansas City, Kan.	4,000
R. Lacy, Inc.	Big Sandy, Tex.	1,300
McBride Refining Co.	La Blanca, Tex.	1,000
McCarthy Chemical Co.	Winnie, Tex.	3,500
MFA Oil Co.	Chanute, Kan.	1,000
Peppers Refining Co.	Oklahoma City, Okla.	1,000
Petroleos Mexicanos	Salamanca, Mexico	10,000
Phillips Oil Co.	Borger, Tex.	12,000
Shallow Water Refining Co.	Shallow Water, Kan.	1,200
Shamrock Oil & Gas Corp.	Sunray, Tex.	1,500
Sinclair Refining Co.	Hartford, Ill.	10,000
Virginian Gasoline & Oil Co.	Clendenin, W. Va.	1,000
		54,200
Other units in operation		75,800
Forty-one (41) operating units		130,000

Under Construction

Oriental Refining Co.	Denver, Col.	1,500
Petroleos Mexicanos	Tampico, Mexico	11,600
Petroleos Mexicanos	Atzcapotsalco, Mexico	11,600
		24,700
Other units under construction		1,000
Five (5) units under construction		25,700
Forty-six (46) total Cycloversion units		155,700

Houdriforming Units

Under Construction

Sun Oil Co.	Marcus Hook, Pa.	11,000
Sun Oil Co.	Sarnia, Ontario*	....

* Under contract

Hydroformer Units

Building or Contracted

Company	Location	Capacity B/SD
Pan-Am Southern Ref. Co.	El Dorado, Ark.*	2,000
Cities Service Ref. Co.	Lake Charles, La.*	19,000
Cities Service Oil Co.	East Chicago, Ill.*	10,000

Earlier Units

Continental Oil Co.	Ponca City, Okla.	3,850
Humble Oil & Refining Co.	Baytown, Tex.	25,000
Pan American Ref. Corp.	Texas City, Tex.	7,500
Pure Oil Co.	Toledo, Ohio	5,500
The Texas Co.	Lockport, Ill.	7,500
Union Oil Co. of Calif.	Oleum, Calif.	8,000
Standard Oil of Calif.		....
Total, 9 of 10 units		88,350

Atlantic Refining Units

Under Construction or Contract

Atlantic Refining Co.	Philadelphia, Pa.†	11,000
Richfield Oil Corp.	Los Angeles, Calif.†	6,000
Total—2 units		17,000
Grand total, 83 of 86 units		374,463

* (Fluid).

† Probable completion date. 1952,

Note—In addition, announcement is expected soon on one or more Socony-Vacuum Units which will employ that process announced recently.—Editor.

of isoparaffins, naphthenes, and aromatics, with some olefins, All except Cycloversion include hydrogen-bearing gases with the charge vapors. Each process generates its own hydrogen supply that is recirculated if necessary.

A typical operation of the Platforming process is about as follows. This catalyst contains small percentages of metallic platinum, whence its name. A heavy naphtha stream of, say, 200-400 F boiling range is fed to preheaters, along with hydrogen-bearing gases at pressures of 750-800 psig, thence to a heater furnace and is brought up to the 900-920 F temperature, is introduced into a first-stage catalyst container or reactor. As the reaction is endothermic the effluent from the reactor is heated up to essentially the same temperature, is exposed to the catalyst in a second reactor, followed by heating and reaction a third time. The product stream is fractionated to recover the motor fuel product and to isolate the small amount of heavier material formed. Part or all of the gas from the reaction is recycled, after compression. Yields range from 90 to 95 per cent, customarily, with octane ratings up to 96 Research with 3 cc. of lead. Normally the more severe the reforming conditions the higher the octane rating and the lower the yield of product.

The Houdriforming process, as are most of the others mentioned here, is recommended for two purposes, for aromatics production and for general motor gasoline (naphtha) improvement. The charge is treated at, for example, 300 psig, and temperatures more or less comparable to those obtained in other reforming processes and when making chiefly motor fuel component has shown yields of 85-90 per cent, plus 5 to 7 per cent of butanes, and with clear octane ratings of 89-90 (F-1), leaded with 3 cc. to 97-97.5.

For making maximum yields of aromatics, normally fractions very high in hexanes to octanes have concentrated in feed preparation units and operating conditions are adjusted to give the best yields of benzene, toluene, etc. Cyclohexane is converted to benzene in yields ranging from 50 to more than 90 per cent, depending on the treating severity. Treating a fraction high in octane shows yields of 30 to 40 per cent of C_8 aromatics, xylenes, ethyl benzene, etc., some toluene and C_9 aromatics, the paraffin content of the charge passing through essentially unchanged, it appears. Conversion of a fraction containing 14 per cent cyclohexane and 23 per cent of methylcyclohexane yield about 16 per cent benzene and 32 per cent toluene.

The new Fluid Hydroforming process applies the Fluid catalyst principle to this formerly fixed-bed process. This permits continuous reaction and continuous regeneration of catalyst and according to information received gives higher yields of higher octane number product than was the case with fixed-bed units. As formerly with the old units this process will produce aromatics in large quantities, aiding in taking care of our needs in this product for aviation fuel, for explosives, for improved anti-knock motor fuels and even for chemical intermediates. For motor fuels octane ratings of up to 95 or higher are obtainable, it is stated.

The Atlantic process employs a catalyst said to contain some platinum, and is applied either to close-cut fractions, in the case of aromatics production in which it is claimed to excel, or to wide-cut fractions for motor fuel upgrading. Temperatures range from 850 to 1000 F with pressures of 300-700 psig. For motor gasoline, this process claims volume per cent C_5-and-heavier yields of 88-95, of octane ratings, clear, from 74, at the highest yields to 85 at the lowest, and with 3 cc. lead up to 96 (Research). A charge stock with more than 50 per cent cyclic C_5s and C_6s yields nearly as much benzene and toluene. A charge comparably rich in C_6s and C_7s shows nearly 50 per cent of toluene, and up to 20 per cent of C_4s, much of the latter suitable as charge for alkylation and/or poly units.

Only meager data have been released on the Socony process although it is understood that a test unit is under construction. It is a high aromatics producer, reports say, with a long-lived catalyst and as are the others, efficient in sulfur removal.

While the 'market' for catalytic reforming units is far from saturated, a great deal has been accomplished in enabling refiners to meet competition from rising octane number fuels from catalytic cracking, and to help them to dispose of low-grade straightrun as a satisfactory fuel. Several reforming units are being built in conjunction with aromatics recovery units, to concentrate the benzene, toluene, etc. for aviation, synthetic rubber chemical, and other purposes. The Hypersorption process as built by Foster Wheeler may be used, it is understood, to recover and/or separate aromatic from paraffinic constituents. Sun Oil has developed the Arosorb process employing silica gel as adsorbent for aromatics, and is building two reformer units.

Understandably enough four new catalyst manufacturing units are being built to make catalysts for cracking and reforming; Davison Chemical, at Lake Charles, Louisiana, makers of Platforming and the Atlantic type catalyst, report says, ($7,000,000); American Cyanamid, Michigan City, Indiana, ($3,000,000); Filtrol Corporation, Salt Lake, Utah, ($3,000,000 — completed); and National Aluminate Corporation, Chicago, making microsphere catalyst cracking. (Completed to "double present capacity," 1950.) * * *

FIG. 1. Fronts of three of the four sulfur-and-sludge burning furnaces at Lake Charles.

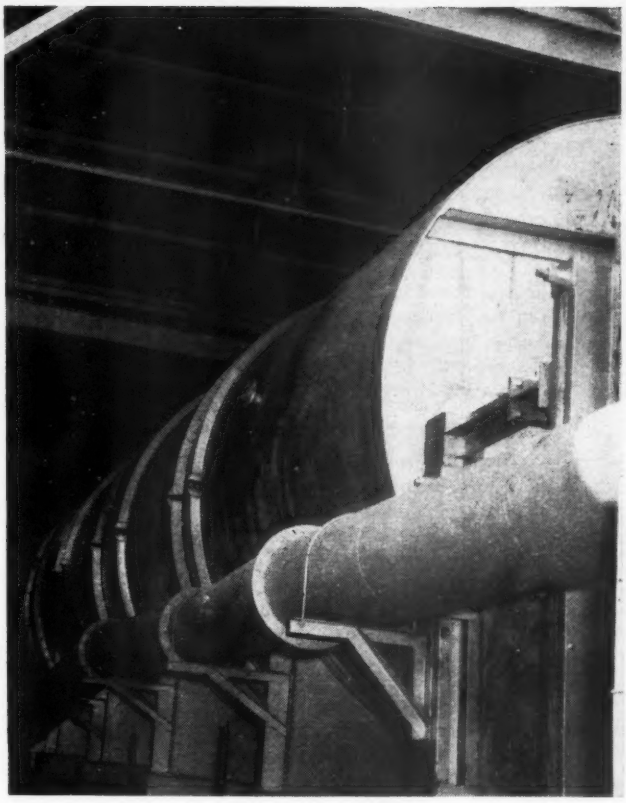
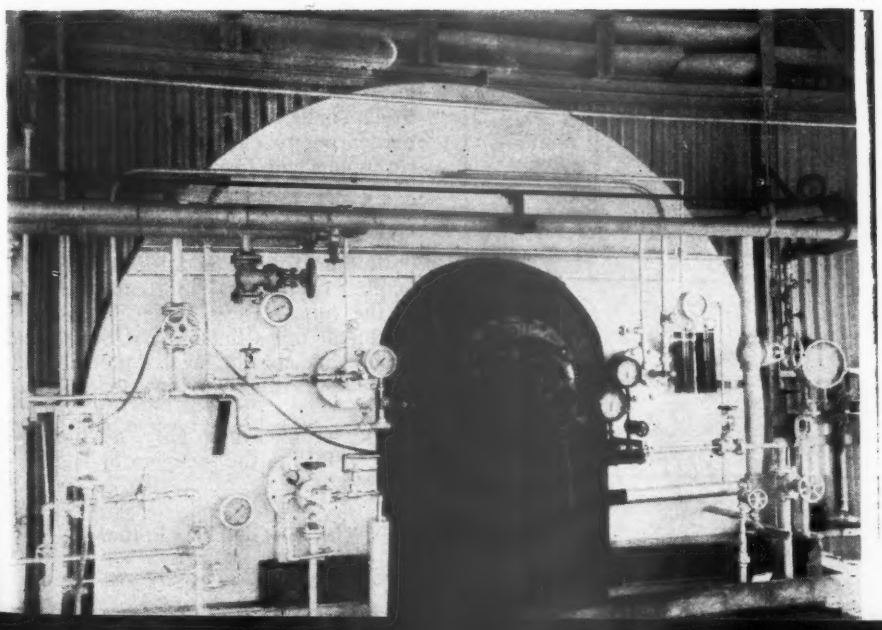


FIG. 2. Body of furnace with exit line for combustion gases en route to recuperator.

Four Sulfur Streams Yield Sulfuric Acid

Two streams of acid sludge—hydrogen sulfide from refinery gases—and elementary sulfur, produce and conserve sulfuric acid

ARCH L. FOSTER*



EXCLUSIVE

SULFUR, the bell-wether of industrial activity in the modern world, has never been in such short supply as it is today. Sources are being tapped that heretofore have been uneconomic; oil and gas companies are finding it profitable to recover as little as 10 tons of elementary sulfur daily from hydrogen sulfide found in refinery and natural gases. Now short

*Editor, Refining and Gas Processing.

FIG. 3. Closeup of front of one furnace, showing the set of burners, each for a different stream.

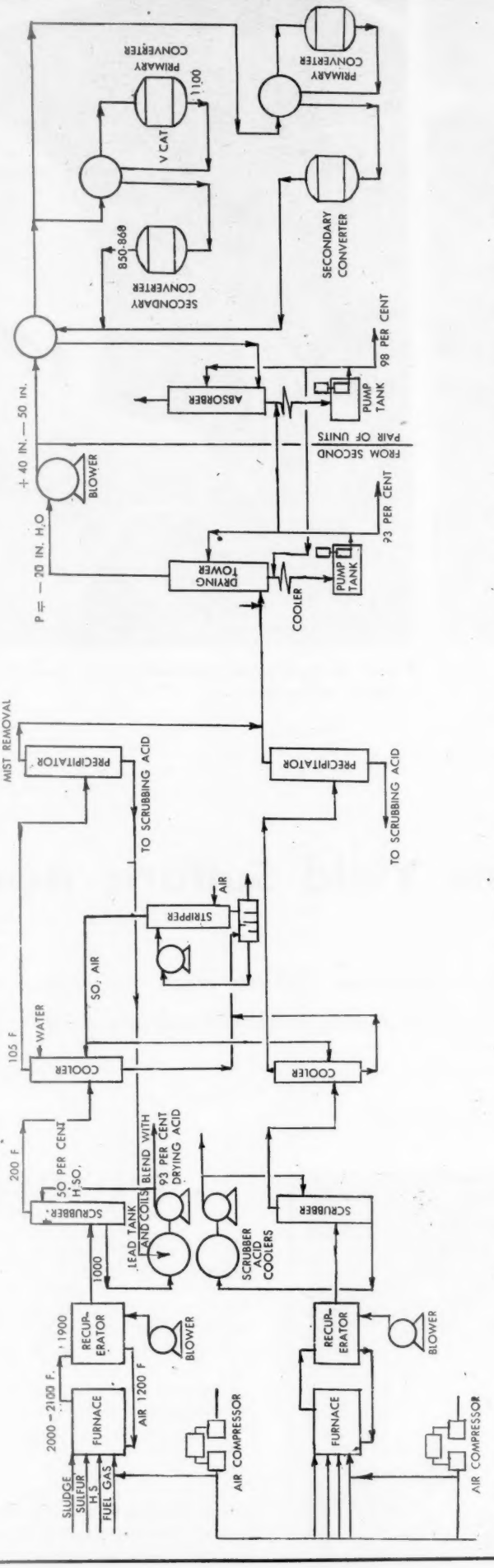


FIG. 4. Flowchart of one of two identical dual units in the acid system. These two units are interconnected but are operated independently of each other.

a million long tons of sulfur annually, present plans show that this deficit should be more than made up by 1953.

This is a story of how one refinery, heavy user of sulfuric acid, recovers its spent acid and converts plant-recovered sulfur and "outside" brimstone to acid of two different strengths to supply the refinery's huge needs. Cities Service Refining Company at Lake Charles, Louisiana, built this unit originally in 1943-44 when its then new plant was erected to boost our wartime refining capacity.

Four sources of sulfur are available to this refinery. The largest single stream is the spent acid from the alkylation unit, which makes aviation alkylate in large quantity. This stream supplies about 300 tons per day of acid sludge, of about 88 per cent strength.

Sources of Sulfur

A part of the spent alkylation acid is used to treat "blend oil," a light kerosine fraction used in No. 2 fuel oil. Kerosine is treated with fresh 93 per cent acid from the acid plant. These spent treating acid sludges provide the second source of sulfur to the acid plant. This stream may be as low as 65 per cent acid but, when combined with the spent alkylation acid, provides a combined stream which averages about 85 per cent H_2SO_4.

A third source of sulfur is the hydrogen sulfide recovered from the diethanolamine solution from the Girbotol unit, which takes hydrogen sulfide from an alkylation unit feed stock. This sulfide, driven from the solution by heat in the solution regenerator column, is burned in a separate burner as shown later herein. The fourth source of sulfur is the addition of elementary product from outside sources in quantity sufficient to maintain the amount and concentration of acid required for the two main streams of sulfuric used by the plant. Combustion of these four streams meets all requirements, and the system shows an outstanding economy according to company officials.

Four furnaces are employed in the system, the fronts of which are shown in Figs. 1 and 3. Each furnace is a horizontal cylindrical steel shell, (Fig. 2) lined with fire brick, and at front is equipped with a main sludge burner, burners for elementary sulfur, hydrogen sulfide and fuel gas, and inlet nozzles for preheated combustion air as outlined later herein. The recuperators immediately following the furnaces are all-brick shells, equipped with Centricast preheating tubes made of 28 per cent chromium and 15 per cent nickel alloy. (Fig. 5). These tubes have proved to be better than carborundum tubes; sulfate salts and coke fuse into the carborundum tubes and stick tenaciously, making trouble and shortening the life of the tubes. These materials stick to the metal tubes but are not difficult to remove and do not involve the tubes as seriously as they do the carborundum type.

The scrubber unit (Fig. 6) immediately following the recuperator is a car-

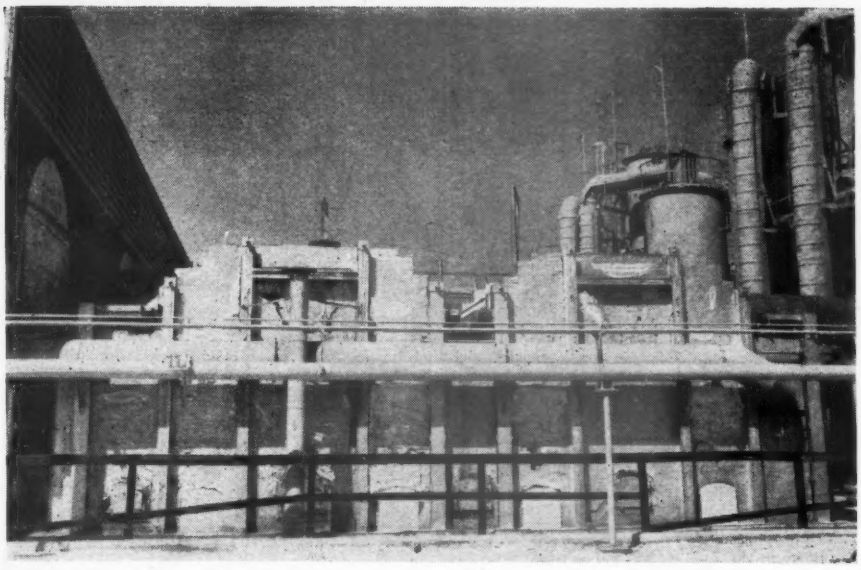


FIG. 5. Recuperators in which gases are cooled, combustion air preheated.

bon steel shell; a solid lead metal lining is installed within this shell, and a second lining of acid brick is placed inside the lead lining. A packing of acid brick fills the lower two-thirds of the scrubber to aid contact between the hot gases and the scrubbing liquid, discussed later herein. The cooler tower is also lead and acid brick lined in a similar manner, with a steel shell, but no packing is installed in this tower, 15 water sprays from three headers serving the cooling purpose. Scrubber acid coolers built mainly of lead are shown in Figs. 7 and 8.

The wash stripper column is also of this shell-lead-brick construction, and is packed with chemical, Raschig-type ceramic rings in each of which a "ramp" is formed as the spiral item. Both body and tubes of the precipitator are of lead metal; tubes are 6-in. diameter. This is a Cottrell unit, and the lead cylinder is one electrode, while the other electrode is a rod extending down each tube. (Figs. 9, 10a and 10b). The drying and absorber towers are both of carbon steel and packed with spiral rings similar to those used in the stripper column.

The converters and their exchangers are all of carbon steel. The gas from each section of the acid plant splits into two parallel streams. Each stream passes through a primary converter and then through a secondary converter. Each of these converters has two catalyst beds. The catalyst is vanadium oxide pelleted into ¼-in. diameter cylinders, about ¼-in. long, and supported on steel grates, which have radial slits out from the center pipe ending at a ring that is concentric with the converter shell and from which new slits continue radially.

Four pump tanks are included, each 30 ft long and equipped with a submerged pump impeller of Ilium alloy, driven by a motor set outside and above the end of the horizontal tank cylinder. For the sulfur dioxide scrubber, and the stripper pumps it was found that non-metallic lines, etc., gave trouble especially by breaking at connections; currently this same Ilium of R-55 alloy is employed with satisfactory results. For the severe service in the stripper surge tank a plastic resin, Haveg, is used and is found satisfactory for not-too-hot dilute acid such as is handled there.

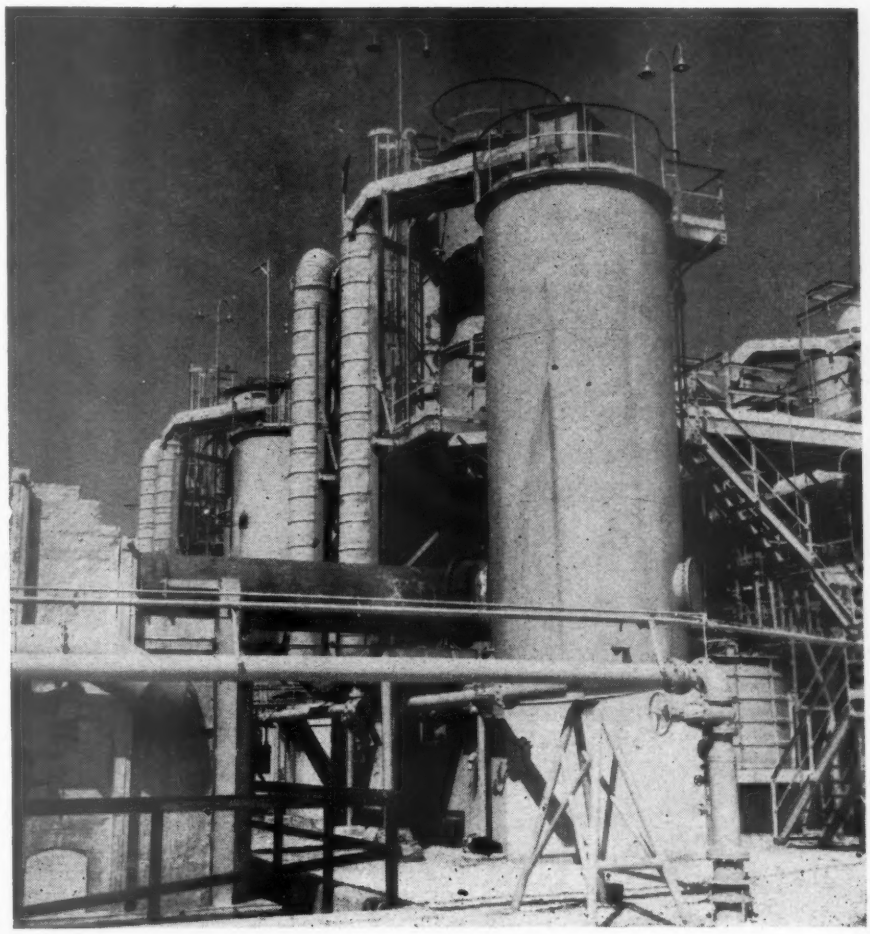
For cooling the strong acid streams, both 93 and 98 per cent concentration, National Radiator cast-iron condenser or cooler sections are installed in a water cooling tower with water sprayed over the outside of these sections. This water is cooled, of course, in the tower, and two sets of sections are provided in each tower, one for each strength of acid.

The catalyst employed is of a yellow cast. When exposed to water in any form it reacts to produce a dark green hydrate, which is regenerated to the oxide at a temperature of about 1200 F.

Operation of Unit

The beginning of the operating cycle of this plant is the combustion of the various sulfur-containing streams in the furnaces, four in number. Each furnace is equipped to burn each of the sulfur-bearing streams. In order to maintain the desired temperature in the furnaces each is provided with a plant gas line and burner and plant gas is burned in such quantities as are needed to maintain this temperature of around 2000 F. Elementary sulfur is melted with steam, and a turbine-type pump is employed to force the melt into the burner. Piping and nozzles are so arranged that incoming air cools the sulfur burner

FIG. 6. Main scrubber tower, showing large horizontal gas line, center, which conducts combustion gases to scrubber.



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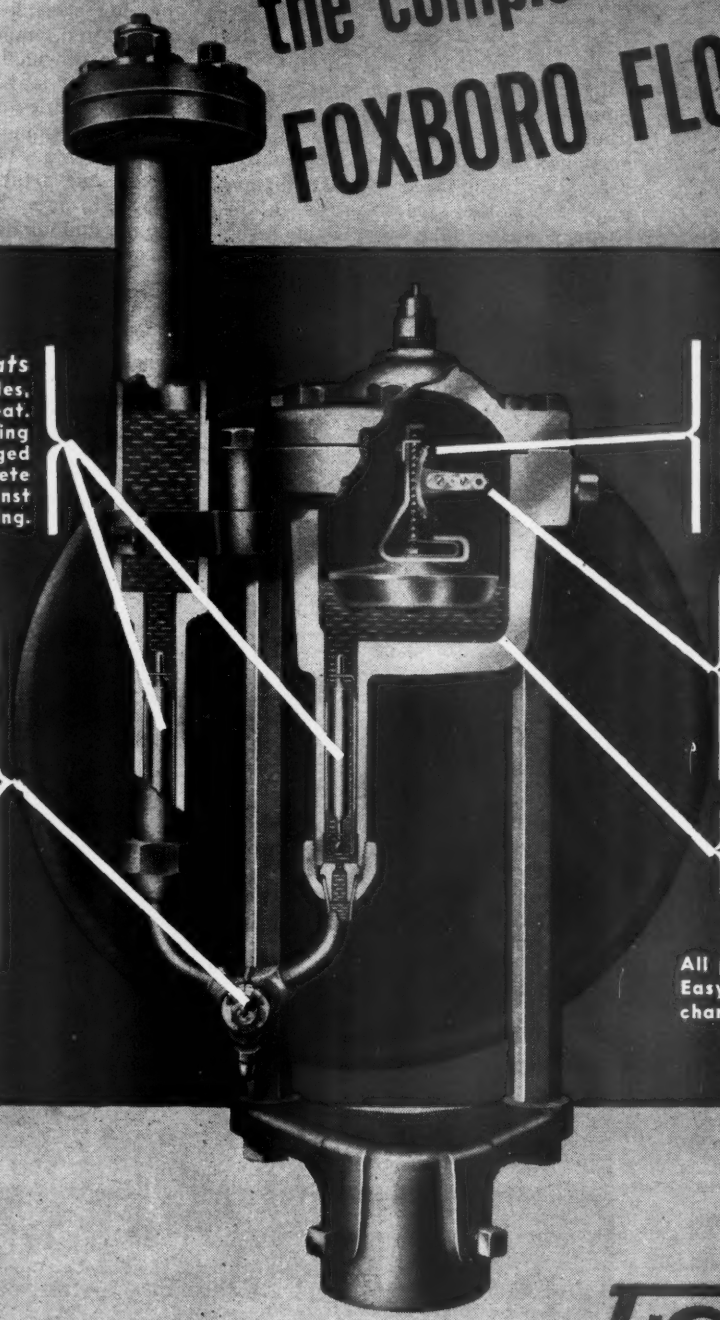

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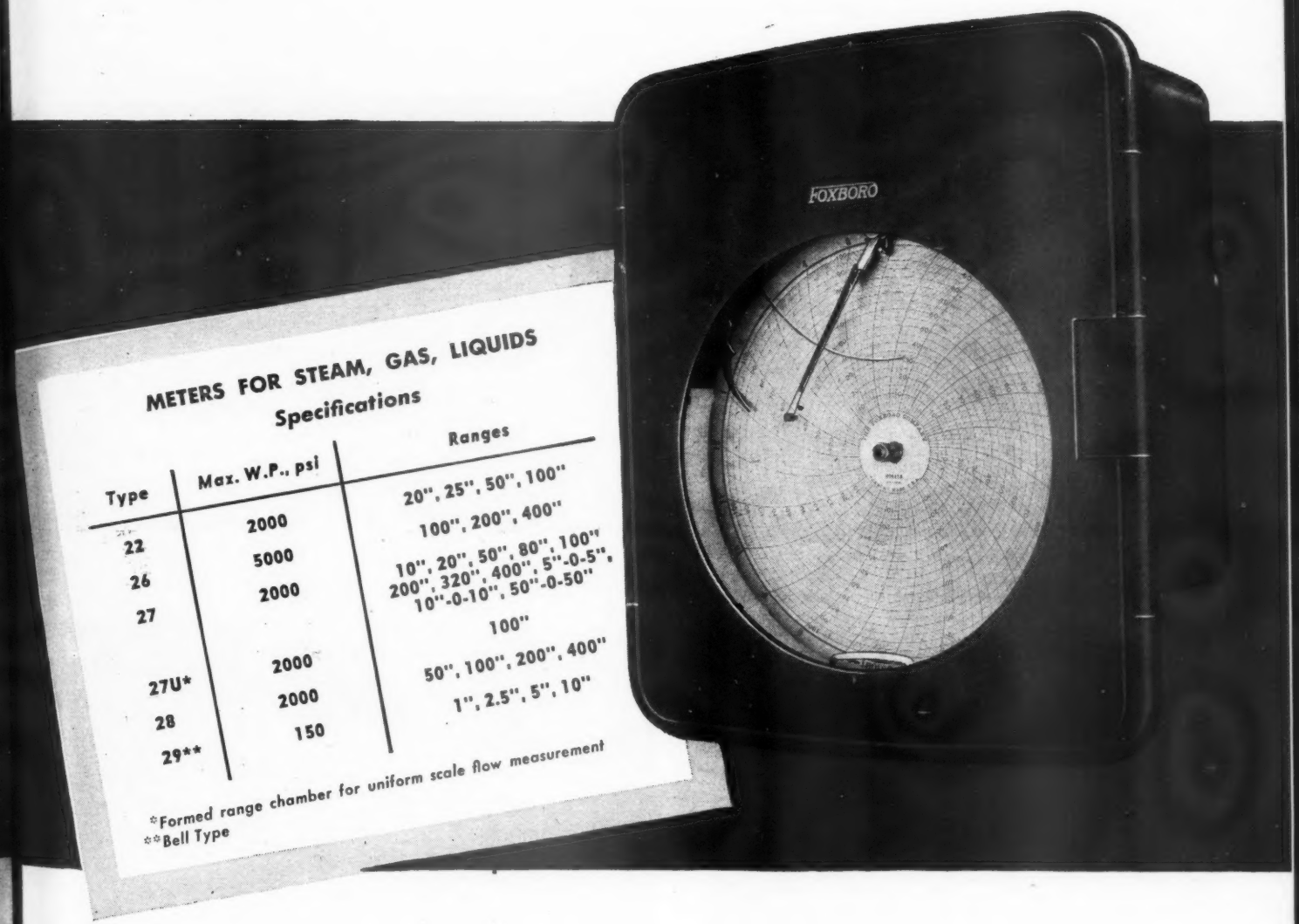

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Type	Max. W.P., psi	Ranges
22	2000	20", 25", 50", 100"
26	5000	100", 200", 400"
27	2000	10", 20", 50", 80", 100" 200", 320", 400", 5"-0-5", 10"-0-10", 50"-0-50"
27U*	2000	100"
28	2000	50", 100", 200", 400"
29**	150	1", 2.5", 5", 10"

*Formed range chamber for uniform scale flow measurement
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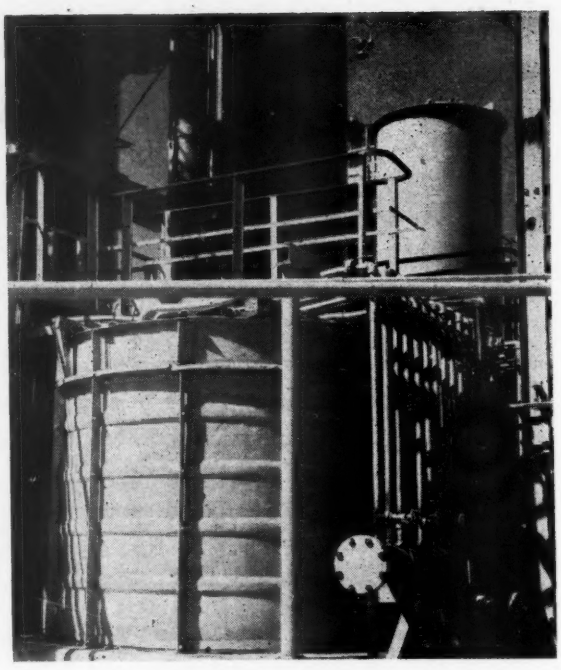


FIGS. 7 and 8. (Left) Lines carrying scrubber acid to tops of (right) coolers. Exit line header shown at center right, with numerous cooler coil lines entering it.

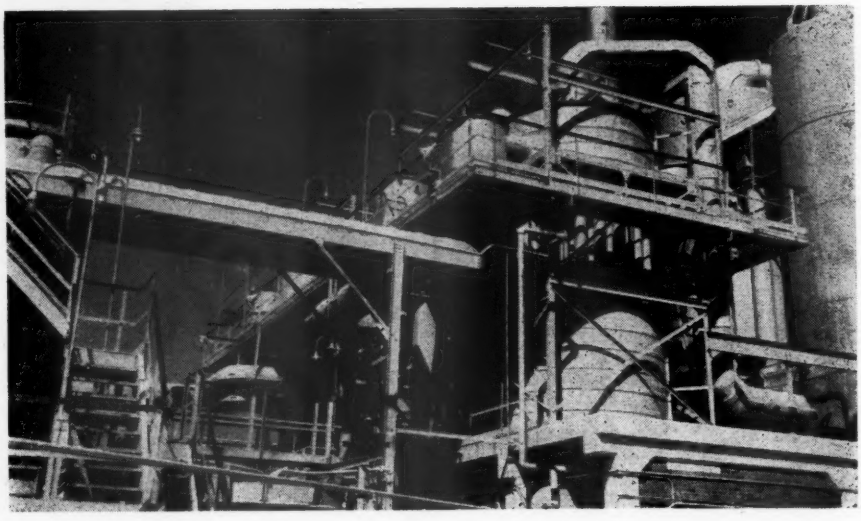


FIG. 9. Battery of Cottrell precipitators, which recover acid mist from reaction gases.

nozzles to avoid melting them in the extreme heat of the furnaces: This is done by admitting air concentrically with and around the burner.

Similarly, the spent acid sludge is forced into its burner and consumed, forming the dioxide and some trioxide from the spent acid. Compressed air is used to atomize the sludge as it is ejected from a spinning-cup type burner. The hydrogen sulfide from the top of the Girbotol regenerator column is also burned and the combined vapors

FIG. 10. Two views of precipitator tubes in the top of the "Cottrells."

PETROLEUM CHEMICALS DIVISION
NEWS

January ★ One of a Series of Interest to the Petroleum Industry ★ 1952

Latest Du Pont Motor Gasoline Survey Due Week of January 21st

The January 1952 edition of Du Pont's Quarterly Motor Gasoline Survey—which reflects nationwide trends in gasoline octane numbers—will start arriving at refiners' offices on January 21. With this edition the survey begins its third full year of continuous publication.

With octane numbers frequently discussed by the press, and public awareness of gasoline quality running high, this issue of the survey is of particular interest.

Refiners have found the Du Pont Gasoline Survey of outstanding value in indicating competitive standings. Many use it also as a sales planning aid.

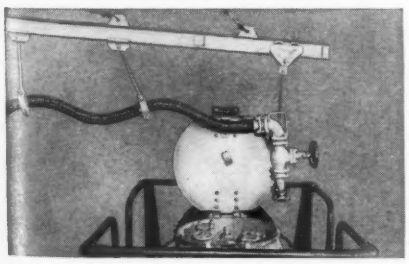
Du Pont-Designed Metal-Flex TEL Unloading Lines Eliminate Many Unloading Problems

Users of Metal-Flex unloading installations designed by Du Pont report that they find many advantages which simplify TEL tank car unloading operations, improve safety and cut labor costs.

Flexibility, for example, eliminates the need for exact positioning of tank cars. This means that one man alone can connect or disconnect the cars. Because older style unloading lines had a tendency to bind, they frequently required two men for this operation.

Flexibility is especially important too, under snow and sleet conditions. Here the Metal-Flex installation is easier to manage than other types of unloading lines.

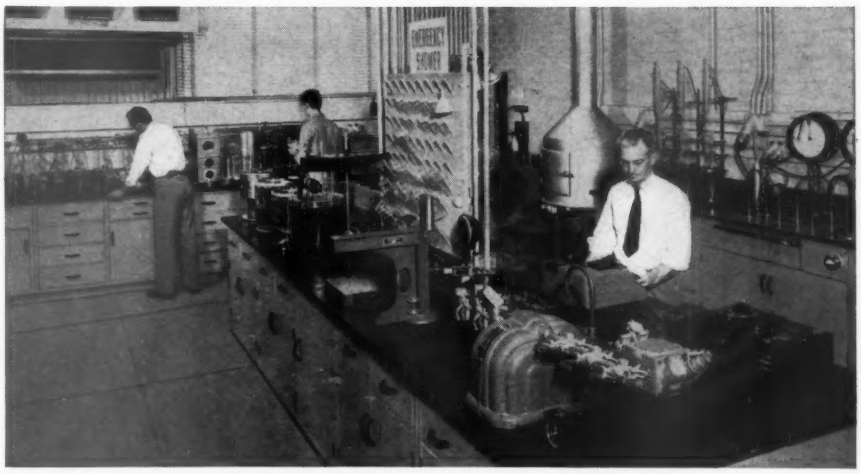
Safety is improved because leaks resulting from stresses are eliminated by the flexible hose and boom arrangement, which also eliminates repacking and the attendant hazards and expenses involved. For more information on the advantages and construction details of Metal-Flex unloading lines, contact your Du Pont representative.



Du Pont Provides Complete Laboratory Technical Service to Meet Specific Refinery Needs

Five fully-equipped Du Pont District Laboratories help refiners in economical use of additives

Whatever your additives problem, technical assistance is always close at hand. Five Du Pont Petroleum Chemicals Division District Laboratories are specially set up for this work. These are conveniently located in El Monte, California; Houston, Texas; Tulsa, Oklahoma; Chicago, Illinois and Wilmington, Delaware. Each is fully equipped to do any required type of testing on motor gasolines. All are happy to be your host if you are in the vicinity.



View of the West Coast District Laboratory inspection section which houses gasoline and light oils test equipment.

New Petroleum Chemicals District Manager Appointments

ALFRED R. MULLIS has been transferred to New York City as Eastern District Manager of the Du Pont Petroleum Chemicals Division to fill the vacancy created by the promotion of Charles Wirth III to Wholesale Sales Manager of the Du Pont "Kinetic" Chemicals Division. Mullis was formerly located in Houston, Texas, as manager of the Gulf Coast District.

Charles D. Towery, former manager of the Mid-Continent District, takes over as Gulf Coast District Manager and Robert M. Glover has been promoted to District Manager in charge of the Mid-Continent District with offices in Tulsa, Oklahoma.

Every day, more and more refiners are making use of this valuable service. And no wonder! It often means a substantial saving for them . . . in time, in money, in effort. And it frequently supplements their own laboratory activity. Here are a few of the many ways the Du Pont District Laboratory in your area can be of service to *you*.

TEL BLENDING STUDIES

To help check new stocks or determine TEL requirements for a specific blend, the District Laboratory will make tetraethyl lead response studies on any or all of your gasoline stocks.

In addition, many refiners use the Du Pont facilities as a check on results found by their own knock-test laboratories. You can also arrange to have fuels road rated by the Du Pont Test Fleet through the nearest District Laboratory. And qualified laboratory

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OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED **District Laboratories**

personnel are prepared to assist you with proper operation of your CFR knock-test engines.

Since Du Pont supplies refiners with a *complete line* of gasoline additives, our District Laboratories are equipped

LABORATORY MANAGER KEN EDSON reviewing results of TEL blending study for a west coast refinery.

to help you gain added economy and efficiency in the use of additives other than tetraethyl lead.

ANTIOXIDANT EVALUATIONS

Du Pont Antioxidants, Nos. 5 and 22, are made to meet the widely varying response of different gasolines to antioxidants. To help you gain the greatest storage stability at the lowest cost, the District Laboratories will determine the most effective antioxidant for your particular stocks. Their recommendations, which include a complete treating plan, are based on induction period and storage tests, as well as standard A.S.T.M. gum tests.

COPPER CONTAMINATION

Whenever you desire, the laboratories can make a careful check on gasoline samples for the presence of copper. Where copper is found, their recommendations for the effective use of Du Pont Metal Deactivator often result in reduced antioxidant treating costs. In some instances savings have been 35% and higher.

DYES—STABILIZERS

Du Pont District Laboratories also provide a comprehensive dye evaluation service. And they are equipped for testing and evaluating additives for many petroleum products beside gasoline. These include fuel oil stabilizers and grease inhibitors.

QUARTERLY GASOLINE SURVEY

Another important job of the District Laboratories is evaluating the hundreds of samples collected every three months for the Du Pont Quarterly Motor Gasoline Survey. To assure that the surveys are both timely and accurate, the laboratory staffs often work day and night.

AT-THE-PLANT SERVICE

Whenever you want assistance on an additives problem *at your refinery*, a qualified member of our laboratory staff will be glad to work with your own personnel.

In addition to local facilities, our District Laboratories are backed by the specialized services of the Du Pont Petroleum Laboratory and by the broad, continuing research activities of the Du Pont Company.

MANAGES WEST COAST DISTRICT LABORATORY

KENNETH C. EDSON joined the Petroleum Chemicals Division of Du Pont in 1947 as manager of the West Coast District Laboratory in El Monte, Calif.

He came to Du Pont from the Southern California Gas Company, where he was supervisor of the Company's research laboratory. Edson joined Southern California as a process engineer in 1943. Previous to this he was a research chemist for the Skelly Oil Company in Pawhuska, Oklahoma.

After graduating from the University of Nevada, Edson studied for a year in the graduate school of Texas A & M College.

DU PONT Historical Highlights

ONE OF THE FIRST organized research efforts in the U. S. chemical industry was Du Pont's Eastern Laboratory, established at Gibbstown, N. J., in 1902. The original staff numbered 3, and was under the direction of Dr. Charles L. Reese.

Today, Du Pont has 42 research laboratories at 27 locations, staffed with 5,000 men and women, of whom 1,800 are engaged directly in research. With the recently completed $39-million post-war research laboratory expansion program, $33,000 is now invested for each research worker – an investment per man which nearly equals the amount it took to put Du Pont in business in 1802.

Literature—Movies Available

Here is a partial listing of the movies, bulletins, reports, booklets and aids available to you through the nearest Du Pont Petroleum Chemicals Division district office:

Pipeline on Wheels—A 26-minute full-color movie on tank truck safety.

What Makes a Gasoline Good—An 18-minute cartoon movie in color . . . on gasoline quality.

Tank Talk—A 52-page, easy-to-understand safety booklet for tank-cleaning crews . . . . . Serial A-1134

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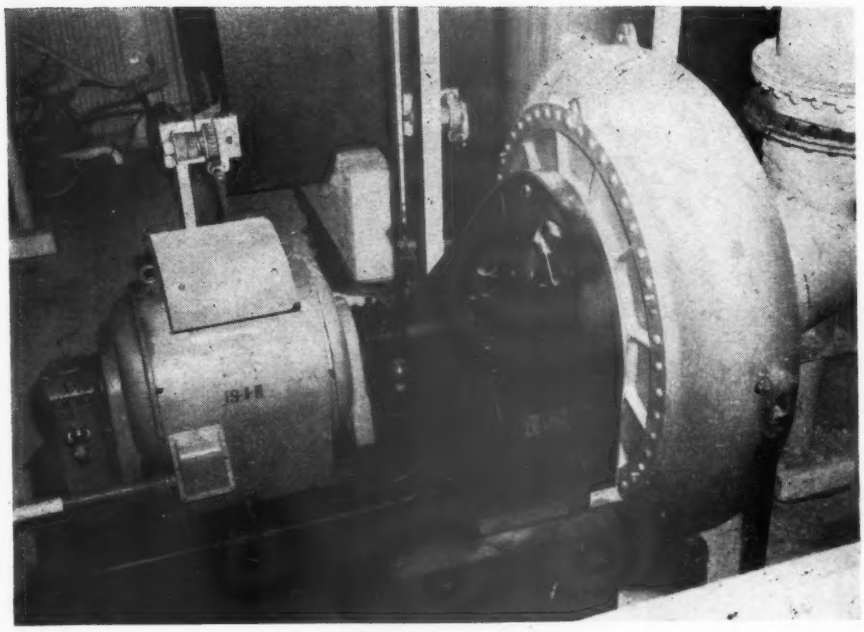


FIG. 11. Main air blower for the unit.

and gases pass to the recuperator. Outside air is admitted to the tubes in the recuperator and is heated to about 1200 F, then is admitted to the furnace to aid in burning the various streams. The gases leave the furnace at 2000-2100 F and enter the recuperator at around 1900 F, from this unit they pass at about 1000 F to the scrubber already described. Over the acid brick in the scrubber a stream of about 50 per cent acid cools and scrubs the gases to about 200 F. This scrubber acid is cooled (Fig. 6) in lead cooler tubes and is sent then to blend with the 93 per cent acid product employed in the drying towers. The gases from the furnaces contain about 15 per cent SO_2 and about 2 per cent oxygen, along with carbon dioxide, water vapor, and some other impurities. Through air leakage and other variants the dioxide content of the gases from the recuperators is 10-11 per cent, with up to 5 per cent oxygen.

Scrubbed gases from the acid-scrubbing tower at 200 F go to the cooler tower, down which a spray of water is sent from the headers. Three sprays are fitted to the top header, with six each in the two headers at lower levels. This action cools these gases to around 105 F; they then pass to the precipitator. Here the potential maintained on the electrodes charges the acid mist in the gases. This mist is composed of finely divided particles of less than 5 microns diameter, mainly so small that normally little if any of the mist can be recovered in any other manner. This voltage differential agglomerates the mist particles that collect on the inside wall of the tubes and flow downward to collect in the bottom of the precipitator. This collected liquid is sent directly to the cooler that handles the 50 per cent acid used to scrub the recuperator gases and continues therewith to the drying acid stream.

The water stream used in the gas cooler that absorbs some sulfur dioxide during the spray cooling, is discharged from the bottom of the cooler into the stripper surge tank; from this tank it is pumped to the stripper and air is introduced to drive off the dioxide that returns to the coolers with the air. The stripped water is discharged or is returned to recycle. This single stripper serves two furnace recuperator systems. It is noted from the flowchart that the four units are lined up into what are actually two systems, each having two furnaces, recuperators, scrubbers, coolers, and precipitators along with air compressors and blowers, also with individual primary and secondary converters and exchangers; each pair of units or "sections" use common strippers, drying towers, reaction gas blowers, and absorbers.

Two separate streams from two precipitators are combined and sent to the community drying tower, where the gases are dried in contact with 93 per cent acid circulated over the tower countercurrent to the gas flow. This drying acid is cooled in the cast-iron cooler sections and discharged to a pump tank. This acid stream is interconnected with the corresponding stream from the 98 per cent acid "make". The submerged pump sends this more dilute acid either to the 98 acid stream, recycles some of it over the dryer again, and sends a portion to rundown as finished 93 per cent acid. The two streams, of different concentrations, are interconnected so that the required strength of acid may be maintained in each stream.

The dried overhead gases plus added air — for oxygen — containing 7-8 per cent of SO_2 and 10-12 per cent of oxygen are sent via a blower to heat exchange with converter gases. The stream is split, each half going direct to exchange with gases from the primary converter in each unit and then into the converter itself at about 880 F. As shown in the chart, the gases pass from top through the two catalyst beds, in turn and out the bottom at about 1100 F, the temperature increase being caused by the exothermic reaction of oxidation of the dioxide to the trioxide. Heat exchange with the incoming gases reduces this temperature to around 825 F and the partially cooled gases pass to the secondary catalyst converter. In the secondary converters the gas goes in the bottom but reverses direction inside the converter and actually passes downward through the two catalyst beds. It then reverses direction again and goes out the top of this converter.

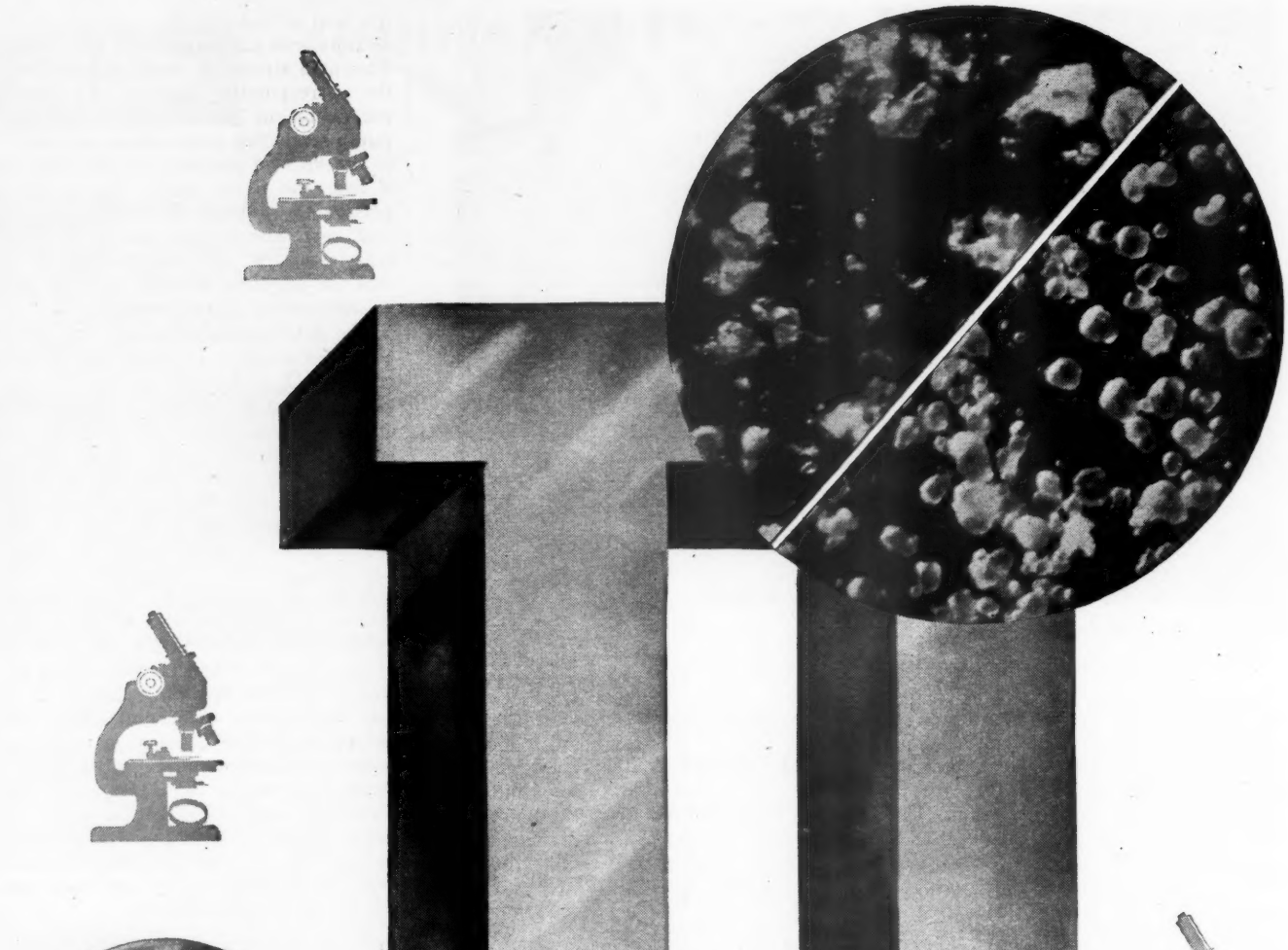
About 75 per cent of the oxidation to the trioxide takes place in the primary converter, the remaining portion being converted in the secondary, the total gases coming out of the last step at about 850-860 F. The two streams from the two converter units combine and go into heat exchange with the incoming combined gas stream, are cooled to some 400 F and enter near the bottom of the absorber, meeting a stream of 98 per cent acid flowing downward that absorbs the trioxide. As the strength of this acid tends to increase due to absorption of the trioxide, 93 per cent acid from the drying tower is used to maintain the strength at about 98 per cent.

The sulfur-free tail gases are vented. The acid is cooled in spray-cooled sections, and recirculated as shown on the chart, and any part may be sent to the drying tower as outlined above, recirculation and interchange being carried on so that the two strengths of acid are produced in the proportions required.

Normally, only about 10 per cent of the plant's capacity of 350 tons per day are made of the 93 per cent concentration, or about 35 long tons daily when operating at full capacity. The remainder of 315 tons is 98 per cent, employed mainly as catalyst in the alkylation plant. Under the conditions some appreciable loss of sulfur occurs during the cycle through the various refinery operations. Normally, the system requires about 15 tons of elementary sulfur daily as makeup, to maintain the plant's required supply of acid. * * *

New Refining Process Upgrades Low Octanes

A new refining process, said to be the world's first fluid hydroformer, is being perfected by refinery and chemical engineers By the process, 55 octane gasolines can be converted into very high octane aviation gasoline. This may be a solution to refiners' efforts to develop methods of upgrading low octane products. Developments like this are the result of the research and progressiveness that permeate the oil industry and are especially noticeable in the refining division.



DEPENDABILITY IN CATALYSTS CANNOT BE SEEN

Top uniformity and dependability are available to you in Davison's microspheroidal (M-S*) or ground (DA-1*) synthetic fluid-type cracking catalysts. The accompanying photomicrographs show the physical characteristics of the DA-1 and new M-S catalysts produced in Davison's Cincinnati plant. Uniform physical and catalytic characteristics result from Davison's modern facilities and years of technical experience and research. Experienced Davison Field Service Engineers—complete laboratory facilities—are all part of Davison Dependability—Dependability with the big "D".

*T.M.T.D.C.C.

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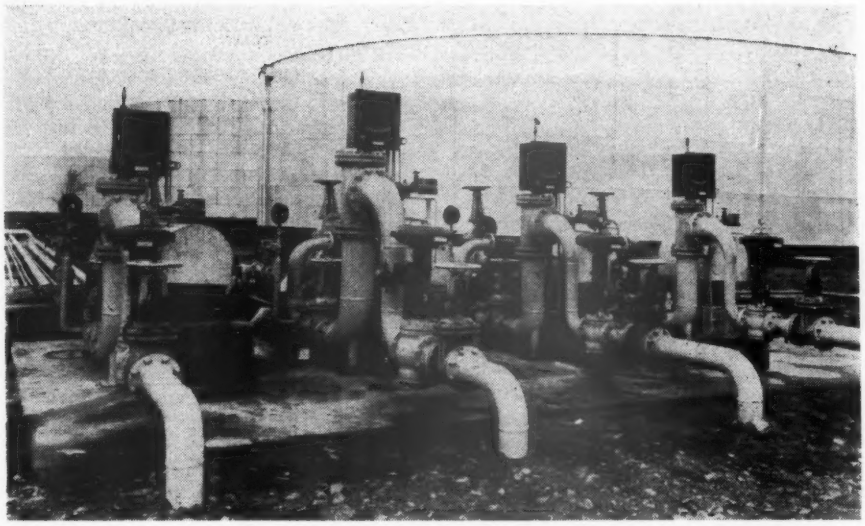


FIG. 1. Ratosleeve Magnabond transmitter-controllers measuring and controlling ingredient flow rates in the first large gasoline line blending system at Shell Oil Company, Montreal, Quebec, Canada.

The Author

John O. Larson, vice president, Fischer and Porter Company, was graduated from Illinois Institute of Technology (Armour) in 1936 with BS in civil engineering. The recession of 1938 found him stranded in the Cincinnati, Ohio, area where he decided process work would be better than construction. He worked in instrumentation at Procter and Gamble's Ivorydale plant, and went with Foxboro in 1940. Larson joined Fischer and Porter in 1944 after several months' assignment to industrial instrument branch at the War Production Board. He worked in the New York office until August, 1950, when he returned to Hatboro for his present responsibility.

Area Type Meters in Refining Applications

They can be used to advantage in corrosive fluids, where vapors are formed or where solids are found in fluid

JOHN O. LARSON*

A RECENT flow measurement handbook, essentially a reprint of the standard practice of one of the large refiners, indicates that area type meters (rotameters) are being utilized to meet 4.8 per cent of the flow rate measurement applications in a "typical large refinery." This was contrasted with 89.2 per cent usage of orifice meters.

Such a comparison shows that area meters such as the Fischer and Porter Flowrator meter are not today a basic tool of the average refinery instrument or process engineer, even though—as we will demonstrate later — a significant number of applications are being very successfully handled.

We cannot perceive any "Doppler Effect" that all might recognize as assuredly telling whether the Flowrator meter is progressing or receding as regards present popularity. It is believed, however, that there have been a sufficient number of applications, ranging from purge meters or flow rate indicators on pump gland seal oil to complete measuring and proportioning systems, to have placed the matter before refinery technical personnel, and the immediate future should show the trend. Of course, a significant fact has been the lack of experience and sophistication on the part of area meter suppliers. By and large, the Flowrator meter has been built for the special requirements of the chemical process industries with corrosion resistance, rangeability, and other advantages of the area type meter providing principal requirements. It is to be conceded that experience has had to be obtained before refinery requirements of safety, flexibility, and adequate information could be met.

This company has recently published an area meter handbook, which presents complete data for the specification, use, and modification-in-the-field of Flowrator meters that represents one of the largest strides yet taken to meet the needs of the industry. Consistent with this standardization of metering elements is the design and production of a simplified and economical Armored Flowrator meter, utilizing a precise cold formed metal metering tube and adaptable to any type of indicating or transmitting extension that can be easily applied and reapplied to various problems as the orifice meter. (see Fig. 2 external and section 2 and 3).

EXCLUSIVE

It seems necessary to fall back upon the introductory comments of that handbook to compare the variable area (Flowrator) meter and the variable head (orifice) meter such that the proper use of each device can be assured and the future significance of each device can be better estimated.

In the accompanying list, it can be seen that the area meter principle brings about certain distinct advantages. Though still an inferential device, it more closely represents a meter that can be calibrated and tested in any laboratory and brought to any point of use with assurance that subsequent data will agree with the response and the accuracy of certification tests. Of course, this statement is not made to imply, as it might have in the past, that each Flowrator meter must be calibrated previous to its installation. With the ad-

vent of the area meter handbook and well-established primary element specifications, the initial sizing and manufacture of the area type meter is as well defined as the more popular orifice practice. (Fig. 4) One or two "Flowrator meter specialists" in each instrument engineering group or maintenance shop will certainly help speed the maximum utilization of the area meter principle. Until such time, the area meter may well continue to be a stepchild assigned to clean-up jobs on those applications where all other more traditional methods have proved inadequate.

It is believed that a fair review of the associated comparisons of area meters and head meters can logically permit us to say that the variable area meter will encroach more and more as time goes on in those measurement applications where the following requirements exist:

Wide range of flow rate.

Good linearity (for flexible proportioning of two or more flows or simple correlation of a flow signal with other linear response variable).

Corrosion resistance.

High viscosity.

Freezing or congealing (strong chemicals, waxes, asphalts).

LPG measurement (gasification in lead lines).

Slurries or streams with suspended solids.

Low pressure drop.

In addition, there should be a continuing use of variable area meters for all measurement of low flows of whatever fluid or whatever requirement if present claims for flexibility and convenience of use are found to be true and accepted by refinery instrument engineers. Coefficient shifts of small orifice meters continue to make the area meter a more dependable instrument for low flow rate work. Excellent repeatability of low flow rates of jet fuel for engine test stand work permits ½ per cent guaranteed maximum deviation from absolute accuracy from maximum to one-fifth of full scale, and checks of normal production run test meters performed at the Bureau of Standards show an average deviation in the order of 0.15 per cent of rate across the entire measurement scale.

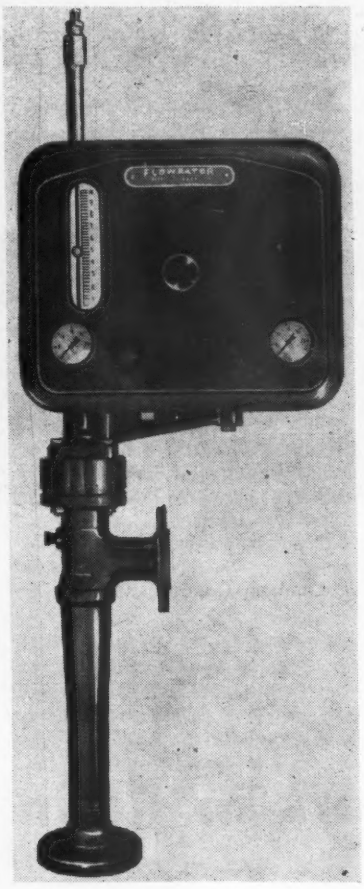


FIG. 2. All metal Flowrator meter Fig. 52 with Magnabond pneumatic transmitter. The Magnabond coupling permits frictionless transfer of float position to secondary instrument mechanisms without the use of a stuffing box. Standard in the V/A Cell, Cable and Drum Levelimeter, and Magnasight.

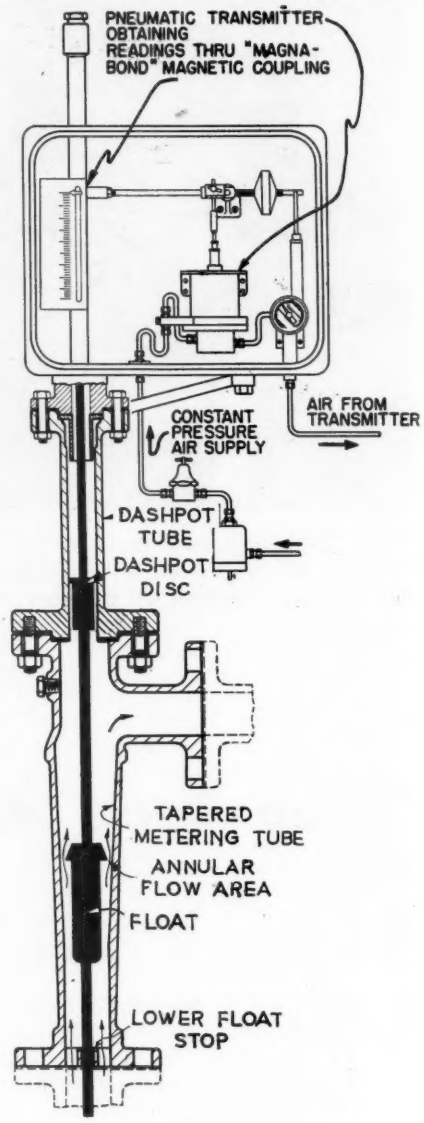
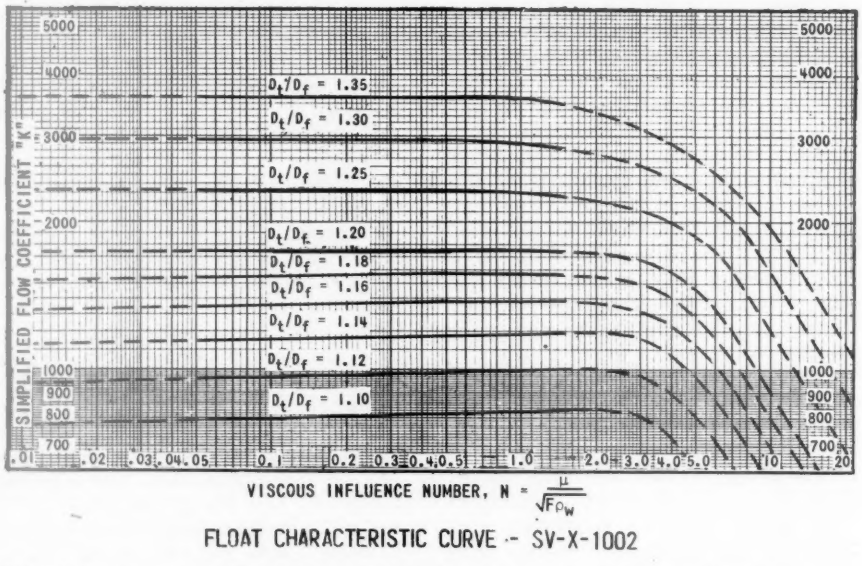


FIG. 3. Cross-section of the Fig. 52 Flowrator meter. This cut shows the dashpot extension between meter and transmitter to stabilize the float for measurement of pulsating flows. The same housing permits float weight addition to increase the capacity of an instrument.



FLOAT CHARACTERISTIC CURVE - SV-X-1002

FIG. 4. Section of predictability curve as published in the area meter handbook. Permits determination of actual flow capacity at any float position by solution of the absolute equation "$W = KD_f\sqrt{F\rho w}$" at any influence number (similar to Reynolds number).

V/A Cell and Oriflowrator Kinetic Manometers

There are adaptations of the area type meter to viscosity work that should be given separate attention as a field of measurement separate to flow rate is involved, and this article will not cover the area meter as a viscosity instrument.

The area meter, however, has been ingeniously applied to differential measurement across an orifice. The Flowrator meter measures the by-pass flow rate created by the differential across the orifice rather than the static differential itself, and the unit is very properly called a "kinetic" or flowing manometer. As main line and by-pass flow rate are proportional in the first power, the kinetic manometer has a linear scale in contrast to the square root scale of the static manometer. It is one of the first radical developments in flow rate measurement as the introduction of the area type meter for general industrial work. (Figs. 5 and 6.)

The Oriflowrator indicator and the V/A cell pneumatic transmitter permit the advantages of the orifice primary to be retained while they contribute the desirable features of wide range and linear scale. Previously, these advantages had only been obtained by special adaptations of the manometer element that included no change of the basic principle. Kinetic manometers are already finding widespread use in many petroleum applications for general measurement as they are applicable to any orifice measurement job wherein a special operating problem has not dictated the use of the area type meter—as in the applications listed at the conclusion of this article.

Installations involving orifice-V/A cell units or orifice-V/A cell combinations with Flowrator meter transmitters are handling gasoline-inhibitor blending, fuel oil-additive blending, and particularly feed water-caustic-phosphate-sulfite blending in large boiler water treatment plants. The variations in water demand and hardness make wide range meters a necessity for water treatment reagent proportioning.

FIG. 5. Schematic drawing demonstrating operating principle of the kinetic manometer and showing operating parts and simple construction of V/A cell transmitter.

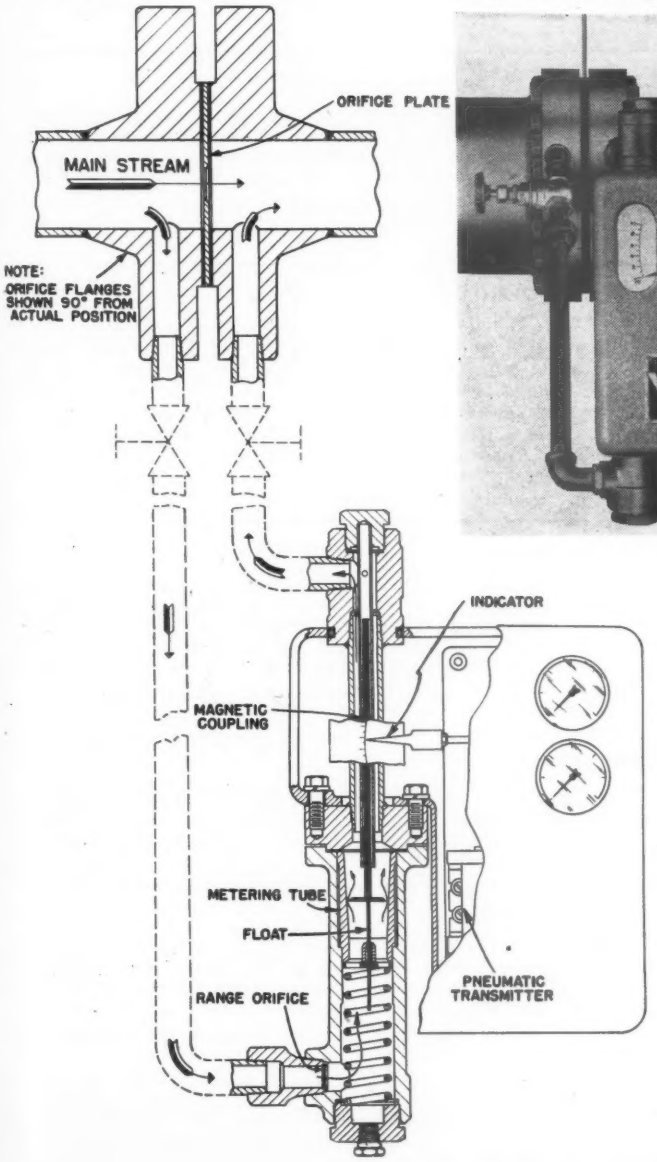
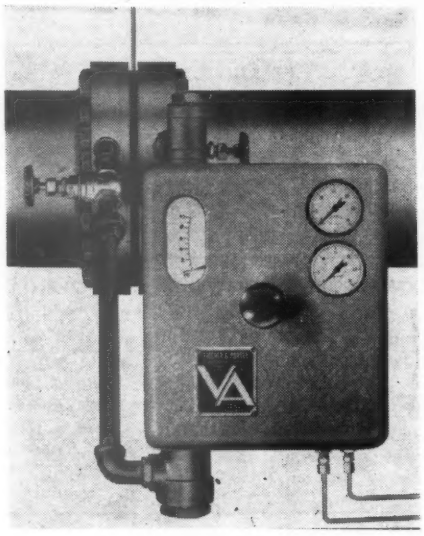


FIG. 6. V/A cell kinetic manometer pneumatic transmitter. New principle permits linear scale, wide range measurement with orifice or other differential creating primaries.



Flowrator Meters in Crude Oil Service

In the Ohio-Pennsylvania field, Flowrator meters are utilized to measure input rate to central storage, and dependable measurement despite pulsative delivery by reciprocating pumps, plus the need for wide range measurement due to delivery from one or more wells, has indicated the use of the area type meter. In addition, viscosity immunity at operating temperatures to prevent significant measuring errors from seasonal viscosity changes was mandatory. A heavy float with high viscosity immunity ceiling handled this problem.

A totalizing Flowrator meter on the receipt of crude from tankers has been carefully tested and approved for Customs duty determinations at one port.

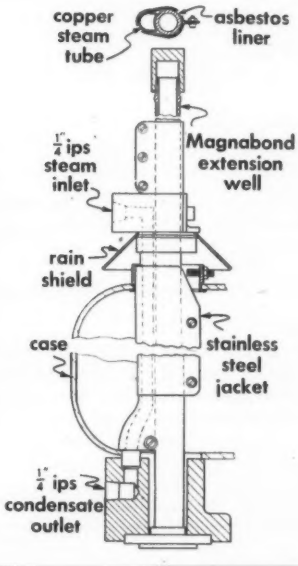
Pipe line and production companies inject ammonia at rates established by Flowrator meters into vapor spaces above sour crude oil in storage tanks to reduce corrosion.

Natural Gasoline Plants

In the Gulf Coast area, numerous installations of Flowrator meters are made on reagents (amine solution, dilute caustic, et cetera) to gas scrubbers. while air and gasoline to gasoline treaters are also conveniently handled. The most distinctive application of the area type meter in this operation, however, is for blending butane and propane to yield LPG at known and constant vapor pressure. Here the ability of the area meter to handle volatile hydrocarbons and its value as a linear primary element in wide range flexible proportioning systems stands out.

The wide range of the area meter also makes it ideal for cooling water service on make-up, return from load, and delivery to the plant from the cooling tower. Independence from the requirement for long metering runs permits a compact, economical installation.

FIG. 7. Steam-jacketed Magnabond extension for use with high pour point streams. New design permits standard Magnabond follower gap and moderate operating temperature in Magnabond instrument case.



Comparison of the Operating Characteristics of Variable Area Meters (Flowrator Meters) and Variable Head Meters (Orifice Meters) with Static Manometers

VARIABLE AREA METER	VARIABLE HEAD METER
SCALE LINEARITY	
"Q" is proportional to "A" in the first power. That is to say, the relationship is linear. "A" is in turn proportional to metering tube ID squared (at the elevation of the float metering edge) minus the float OD squared. Plotting float travel versus "Q" gives almost a straight line. (This slight curvature is rapidly corrected in either the transmitter or the remote exhibiting instrument.) Flow ranges of 10 to 1 or greater are readily handled.	Since "Q" is proportional to the square root of "h", the capacity scale is quadratic with intervals between graduations, representing a given flow increment, becoming ever smaller at the low capacities. Thus the satisfactory range of measurement of the variable head meter (without altering any of its components) is limited to approximately 3½ to 1. By giving the manometer elements a special shape, the scale increments may be made uniform. However, the design principle is not altered, and this method magnifies low differential pressures with consequent uncertainty of performance.
FLEXIBILITY	
The variable area meter has lagged behind the variable head meter as to flexibility where it is desired to move flow meters about from service to service as conditions dictate or where the capacity range of individual meters is to be altered even though they are not moved to a different fluid stream. However, with the introduction of uniform float travel (regardless of size of the meter or capacity selected); with the introduction of percentage scales; with the use of predictable performance floats and tabulations of dimensions and other physical characteristics of floats; the plant instrument engineer is put in a position to alter floats and reapply variable area meters to different flow streams with the same confidence that he has in the past altered sharp edged orifice plates, manometer ranges, or relocated variable head flow meters onto fluid streams of different characteristics.	Flexibility, which the sharp edged orifice plate variable head meter permits in respect to altering capacities and shifting to different flow streams, has been one of its outstanding advantages ever since thorough test programs were carried out by the ASME, AGA, in the U. S., and the International Federation of National Standardizing Associations (ISA) in Europe. This standardization of designs of orifice plates, locations of taps and methods of attaching them, upstream and downstream piping limits, and the plotting of reliable graphs showing flow coefficient "C" versus Reynolds number has permitted orifice meters to be readily moved from one system to another.
PRESSURE DROP	
Since "h" is a constant in any one instrument, it can be determined by the weight of the float, and since the value of "h" may be pre-selected by suitable selection of float weight and diameter, the metering pressure drop is both constant over the entire range of the meter and can be made as low as desired. (Metering pressure drop as low as 0.1 in. of water has been obtained with specially fabricated floats.)	Since "h" is the variable and since its magnitude varies as the square of the flow rate, the pressure loss increases rapidly as flow rate increases. Minimum design pressure loss is limited by the pressure differential which will create a significant deflection of the manometer measuring device.
COMPLEXITY OF METERING COMPONENTS	
The metering float serves a triple purpose: the flow obstruction, the flow response device, and the reading indicator. Thus no external devices are required where direct indication alone is desired. Simple transmitters of magnetic and electromagnetic types are attached to the float without altering its fundamental simplicity.	With "h" the variable to be ascertained, it is necessary to provide not only the flow restriction itself, but some sort of external manometer chamber to which two pressure lines may be brought from opposite sides of the restriction and in which some element sensitive to pressure differences such as mercury (or other liquids), metallic bellows or diaphragms must be employed. Condensable vapors, corrosive fluids, and fluids that crystallize or congeal all require additional complexities in external metering components.
LARGE FLOW MEASUREMENT	
While there is no theoretical limit to the size in which the variable area meter may be constructed, the bulk and weight will increase as the square of the pipe diameter. Therefore, costs, weight, and handling problems become considerations when variable area meters are used for large pipe sizes.	As pipe size increases, all elements of variable head meters remain the same except the restriction inserted in the main line. If this restriction is of the commonly used flat plate orifice design, the extra material required for large diameter installations is not significant and no difficult machining problem is encountered. Therefore, neither weight nor cost increase substantially.
SMALL FLOW MEASUREMENT	
Variable area meters are particularly suitable for small flows and have been used to accurately measure less than 0.1 cc/min. of liquid and 1.0 cc/min. of gas.	The value of flow coefficient "C" tends to become unstable and difficult to predict in pipe sizes below 2 in., and accuracy of measurement becomes steadily more unreliable as pipe size and capacity are reduced.
EFFECT OF DIRT—EASE OF MAINTENANCE	
Due to the annular flow passage arrangement, the variable area meter tends to be self-cleaning. A scouring action of the fluid flow against both the float and the tube wall tends to prevent adhesion of foreign matter. A large obstruction may lodge under the float, but the float can rise beyond the top of the metering tube, discharge the obstruction, and fall back into its proper position. Where pyrex tube meters are used, visual inspection is effortlessly available.	Foreign matter frequently accumulates in the relatively stagnant pockets formed by the restricting device. Dirt, gas bubbles (in the case of liquid measurement), liquid drops (in the case of gas measurement), may accumulate in the lead lines of manometers and visual inspection is not possible, so disassembly is required to determine if cleaning is necessary.

Continued on Page C-19

COMPARISON OF THE OPERATING CHARACTERISTICS OF VARIABLE AREA METERS AND VARIABLE HEAD METERS—Continued

VARIABLE AREA METER	*VARIABLE HEAD METER*
PULSATING FLOW	
Under the ideal conditions that the oscillations of the float correspond in amplitude exactly to the amplitude of flow pulsation, then the average reading will be the correct reading. However, in a pulsating flow stream, if the float of the variable area meter is provided with a dashpot so as to almost completely dampen out the pulsations, the readings obtained will be erroneous to exactly the same extent as the readings of the variable head flow meter in that the flow readings obtained by taking the linear average of the pulsations will be the root mean square of the actual flow.	Variable head meters used in a pulsating fluid stream will tend to read high, for the square root of the average differential (determined in a dampened manometer) must differ from the desired average square root which an instrument cannot determine.
APPROACH FACTOR	
The float of the variable area meter acts as a series of impact tubes, that is, like pitot tubes. Thus it is sensitive to and detects not only that velocity which is added to the fluid stream at the restriction, but also the velocity of the approaching fluid stream. Therefore, no approach factor correction is needed in making calculations for individual variable area flow meters.	The manometers of the variable head flow meters are sensitive only to the additional velocity which is created at the restriction except in the case where a pitot impact tube is substituted for the more common orifice plate restriction. Therefore, calculations of ordinary variable head flow meters must include a factor by means of which the velocity of the approaching stream is added to the velocity generated at the restriction to obtain total velocity.
EFFECT OF UPSTREAM PIPE	
The combination of tapered tube and float obstruction acts as a flow distributor to provide relatively uniform velocity to all portions of the annular orifice. Thus the effects of upstream elbows, valves, and other bends are mitigated to such an extent that most variable area flow meter measurement is independent of upstream piping arrangements.	Considerable lengths of straight pipe must be allowed upstream (and also to a lesser extent, downstream) or straightening vanes must be installed to provide a uniform flow pattern for reproducible flow measurement. The manometer taps must be accurately located, carefully made, and smoothly finished.
ACCURACY	
Accuracy guarantees for variable area flow meters are overall guarantees and represent what an engineer would expect them to mean: The degree of accuracy with which the final exhibiting device will reflect the actual flow rate in the pipe line. Certifications as to the accuracy of individual meters are frequently issued, and these state the accuracy at all portions of the scale and may be expressed in percentage of instantaneous flow rate rather than of maximum flow regardless of the fraction of maximum flow which is actually being metered.	The head type meter involves so many elements—most of which are not in the hands of the manufacturer because they are installation conditions—that accuracy guarantees are often meaningless except concerning manometer differential accuracy. Calibrated metering runs including orifice, flanges, and proper taps, with necessary upstream and downstream piping can be provided, but—except in extremely small sizes—these are not economical. It is conceded that orifice practice can be careful enough to permit orifice meters to provide accuracy subject to the deviations listed for published coefficients with minimum allowance for carelessness or error in installation.

Refining

Many refineries are using Series 700 glass tube meters on anhydrous ammonia in the liquid or gaseous phase to fractionating tower vapor line to inhibit corrosion when running sour crudes.

Tower bottoms and tar at 600-700 F are being handled at many refineries. A simple steam-jacketed extension for the popular Magnabond recorder or transmitter maintains the heavy residuum above its pour point. (Fig. 7) Incidentally, a Canadian refinery purchased a large number of area meter transmitters having jacketed extensions for all heavy ends and chemical solutions to assure continuous operation during the winter period. This entirely eliminates the problem of freeze-ups of water in external lead lines of manometer systems.

This same refinery has the first large installation of area meters on the perpetually troublesome catalyst slurry (liquid) lines at the cat cracker. Hardened 440 stainless steel metering edges show no erosion after one year, and another refinery of the same company is considering conversion to area meters on this service.

A particularly successful installation at a Gulf Coast refinery covers the measurement of a side stream cut with extremely low pressure drop and wide flow range caused by variation in feed stocks. A Midwestern refinery has a low pressure drop meter on unstabilized gasoline, metering satisfactorily very close to equilibrium conditions without flashing.

The relatively low flow rates of high viscosity Bunker fuels to furnaces are satisfactorily metered with Flowrator meters at many refineries, and waste gas or natural gas for the same application can give wide rangeability requirements that also require the use of the Flowrator meter.

Gasoline inhibitor ratio control is another popular requirement for Flowrator meter blending, and an entire pipe line gasoline blending system involving nine elements is operating at the Shell-Montreal refinery (*The Petroleum Engineer*, September, 1951). (Fig. 1) Rangeability and accuracy were requisites on this installation. Incidentally, these instruments were precisely calibrated in the presence of the customer's project engineer in our fluids engineering lab.

The critical problem of measuring streams satisfactorily in an HF alkylation unit has been overcome through the use of Flowrator meters, and a large installation at a Midwestern refinery has completed approximately a year of service without downtime. Many other installations exist, and sulfuric acid alkylation streams, of course, are handled equally well with the area type meter. These are typical corrosive, solids-bearing streams in the refinery where the Flowrator meter approach has solved traditional problems.

Many refineries have made the measurement of alkylation spent acid a guinea pig, and good performance on this nasty service has been obtained. Slop oil skimmed from separators is another in this category.

Acid Plants

Quite a few refineries operate their own sulfuric acid plants and—as is the custom in many process plants supplying sulfuric acid—the measurement of molten sulfur for control purposes is a usual entree into the process.

Spent acid measurement and extract-acid measurement for by-products operation have provided spectacular relief from service problems when other types of flow rate measurement had been

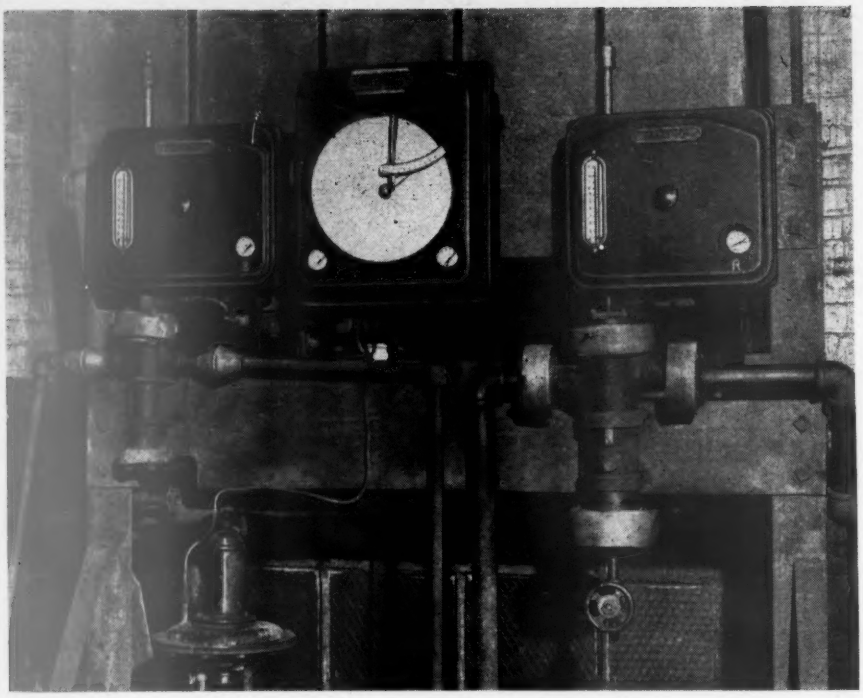


FIG. 8. Photograph showing armored Flowrator meter transmitter with ratio controller on white oil-oleum blending at Bayway, New Jersey refinery of Esso Standard Oil Company.

tried. In one Eastern refinery, successful measurement of strong acid solved a considerable operating problem—the principal pump was putting out three-quarters of claimed capacity.

By-Products

Of course, the extensive by-products operations conducted in conjunction with some refineries are complete chemical operations, and this becomes an entirely separate problem. Such problems, however, as oleum-acid oil blending for white oil refining again typify the multiple ability of the area meter to handle corrosion, suspensions (pepper sludge in the acid oil), and provide wide range proportioning as a premium. (Fig. 8)

Handling of Wax

Measurement of waxy raffinates and other streams becomes as reasonable and as successful as the handling of heavier ends from the asphalt base crudes. Solvent de-waxing with a Ratosleeve is not only desirable because of the ability of the area meter to handle wax and solvents but because of economies of floor space desirable in treating units due to the elimination of the need for metering runs for orifices. (Fig. 9)

Chilled paraffin distillate with 10 per cent wax crystals is metered successfully at a Gulf Coast refinery.

At one refinery wax sweater operation, glass tube Flowrator meters, complete with proportional reset control, are used for automatic control of heat input. This arrangement was found to be more satisfactory than the original cascade control system in which the Flowrator meter controller reset the temperature controller index.

Lube Oils

Acid refining of lube oil was actually one of the first Flowrator meter applications after the rotameter became fitted up with transmitting and control functions. Several successful installations exist, and again the ability to provide good measurement in the face of reciprocating pump delivery, high viscosity, and considerable corrosion — concluding the entire package in a flexible, wide range proportioning system— proves the versatility of the Flowrator meter. Another interesting application in the lube oil plant includes a battery of flow rate indicators for balancing flow rates to multiple lube oil filters.

One of the very popular applications of area meters in Gulf Coast refineries is on phenolic water and phenolic vapor in phenol treating of lube oils. In particular, one refinery reported that a Ratosleeve totalizer on phenol plant extract tower bottoms has permitted them finally to make the first good material balance on the unit. (Fig. 10.)

Caustic

Beginning with the continuous dilution of concentrated (72 per cent) caustic by ratioing water to hot strong caustic from the tank car permitting direct storage of 50 per cent strength. Flowrator meters are used for a variety of caustic measurement and control problems, at fixed rates or as elements in proportioning systems.

Chlorine

Chlorine is used for many refinery problems, particularly for inhibiting growths in cooling water that reduce heat transfer efficiency, and area meters have become standard for these problems. The Flowrator meter is the basis of the Fischer and Porter complete chlorinator, finding wide application in refineries. * * *

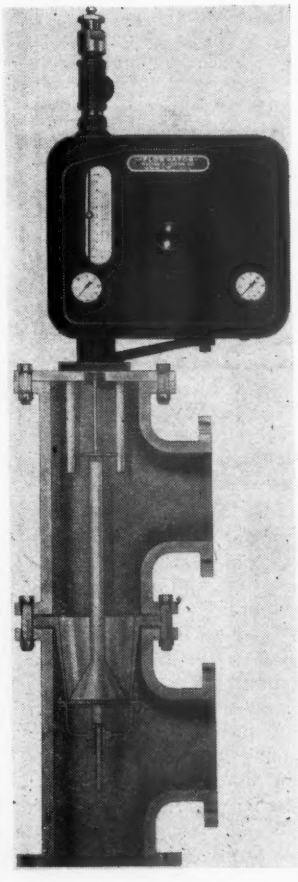
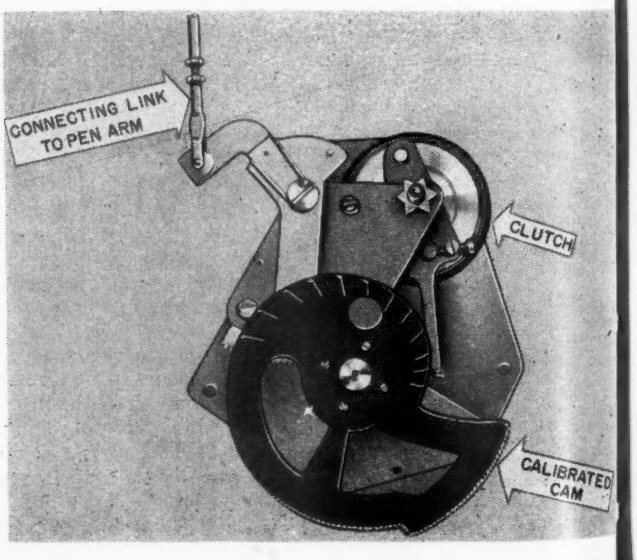


FIG. 9. Ratosleeve meter with Magnabond pneumatic transmitter. Metering elements are economically installed in standard tee fittings to provide high capacity area type meter.

FIG. 10. Flowrator meter totalizer showing large (7-in. effective cam surface) plastic cam development in polar coordinates to exact flow curve of the meter.



Blending tanks tops of which are fitted with fume ducts.

Largest Lubricants Plant In Britain in Operation

V. S. SWAMINATHAN

THE largest plant in Europe for manufacturing lube oils and greases, and the only vertical installation for producing lube oils in the United Kingdom, at Barton, Trafford Park, Manchester, was formally opened by Sir Frederick West on September 25. The factory comprises the following units: New plant for blending, packaging, and disposal of lube oils, including facilities for bulk loading of road tanks and rail cars; equipment for preparing and reconditioning packages; installation for manufacturing, packaging and dispatch of greases, and a building housing a laboratory and administrative offices. It is admirably situated on the Manchester Ship Canal, which makes for economic supply of raw materials and delivery of finished products. The main road bisects the establishment. The southern site contains the tank farm with a capacity of 21,000,000 Imperial gallons, and constructional and maintenance shops. In the northern site is the grease plant. There is a jetty from which oil warmed in the cargo of oil tanks of the tanker is pumped through 8-in. diameter overhead pipe lines to the tank farm. Steam heating coils in the main storage tanks serve to insure a viscosity at which the oil can be readily pumped. The basic stock comes from domestic and foreign refineries—Stanlow, Shellhaven, Curacao, and Pernis.

The stock for the lube oil plant is delivered from the tank farm by means of steam pumps to a distribution point at the ground level. From here 5 horizontal duplex steam pumps, each having a capacity of approximately 60 gross tons per hour raise the oil through a height of about 80 ft to fill the 50-ton capacity storage tanks numbering 20. The latter are 30 ft long by 9 ft diameter and have steam heating coils to maintain the oil at the right viscosity. These tanks are interconnected and each contains a different component oil. Pipes from each tank are led to open distribution boxes, which act as funnels on the storage tanks through the distribution boxes (each serving 6 blending kettles) to a battery of 20-ton capacity totally enclosed blending kettles, of which there are 16. These kettles are calibrated, and "pneumercator" gages indicate the quantities in pounds so that the amount of each constituent required for a specific blend can be checked within a close degree of accuracy. Perforated pipe coils within the kettle carry air at about 10 psi, and the air escaping through the percolations creates turbulence and ensures that the oils are thoroughly mixed. Steam heating coils are also fitted within the kettle and assist in the blending by raising the temperature and reducing the viscosity. Gage boards on the control platform mount temperature indicators, the normal range of temperature being from 60 to 140 F depending on the specification of the oil.

EXCLUSIVE

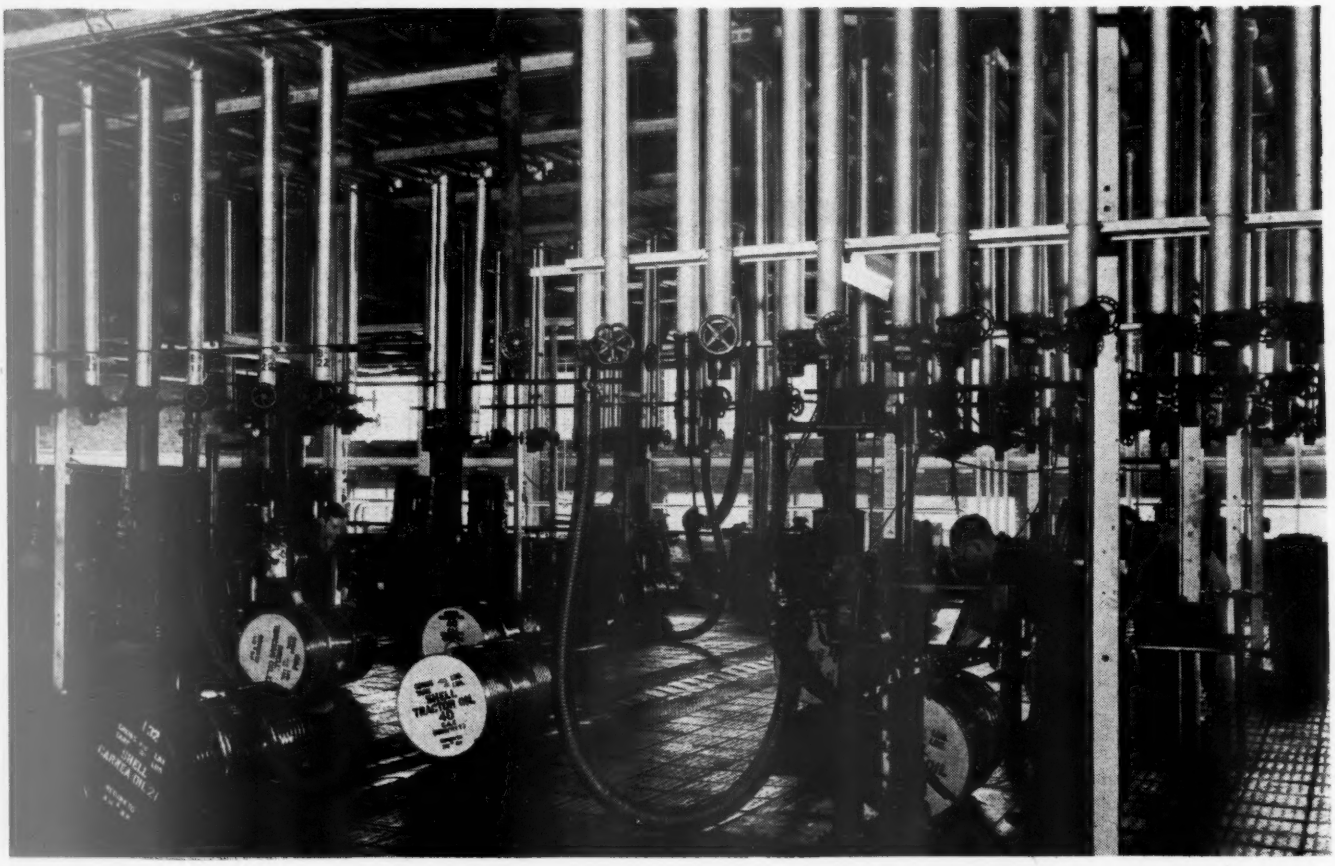
THE AUTHOR

V. S. Swaminathan is an honor graduate in geology from Presidency College, Madras, India. Later he was geology research scholar at Madras University, assistant professor of geology at Presidency College, later taking special courses in engineering geology and oil technology at the Royal School of Mines in London.

He has written articles on numerous phases of the petroleum industry in Eurasia and western Europe for several years, including investment, statistical, and economic fields as well as in technical and scientific developments. In recent years he has toured Asia Minor and contiguous areas studying the oil industry in the Middle East, as well as in southern and western Europe, and is well acquainted at first hand with the refining industry, research, and development activities in Great Britain, Italy, France, and other European countries in which rebuilding of refining capacity has been very active since the end of World War II.

Delivery lines leading from the blending tanks to storage tanks serving filling points.

At Barton plant—ground floor of filling building (showing electric weight control) barrel fillers and continuous floor conveyor belt leading to warehouse and road or rail loading points. Forty separate grade lines are duplicated for 80 filling points or 8 machines.



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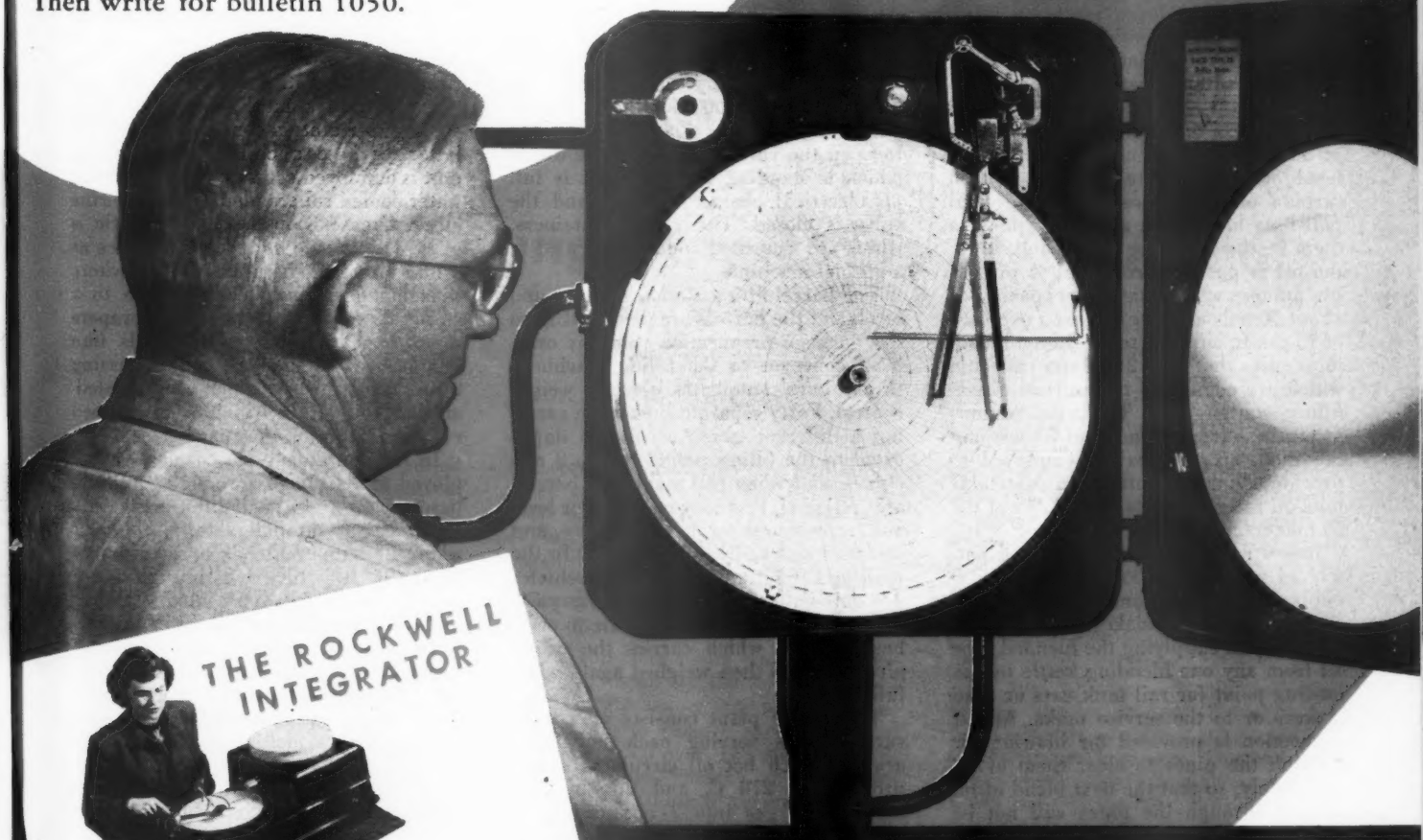

THE ROCKWELL INTEGRATOR

Mechanically calculates orifice meter charts of various makes. Extension appears as a total on a straight reading register. Operator traces contrasting colored lines over static and differential records to verify results. One Rockwell integrator will handle upwards to 300 average charts a day.

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Main laboratories showing grease, lube oil and fuel oil test benches.

The various fats required for lube oil production are delivered in barrels at the ground floor level, where an infra-red heating muffle is dropped into each barrel to melt the fat. The molten fat drops into a tank heated by steam coils from which it is pumped to the distribution boxes by horizontal duplex pumps of 30 tons per hour capacity through a head of approximately 50 ft. Certain turbine oils and those requiring final polishing have earth and lime added to them in the blending kettle, and, later, the oil is passed through filter presses by pumps which have a capacity of about 40 tons an hour against a pressure of 75 psi. In addition to the 20-ton blending kettles there are 2 of 5-ton capacity, which are connected to the road-wagon filling station only. The road wagons generally have a capacity of 5 tons, and the small size kettles are employed to provide a small quantity of a particular lube oil rather than call upon one of the 20-tonners.

Below each blending kettle is a battery of pipe connections, together with appropriate valves, and this system of multi-connections makes for greater flexibility in supplying the blended lube oil from any one blending kettle to any loading point for rail tank cars or road tankers or to the service tanks. An air connection is provided for blowing air through the pipes to clear them of oil completely, so that the next blend of oil to pass through the pipes will not be contaminated. Barrels and drums are filled from the 16 two-compartment service tanks, but by-pass arrangements are also provided.

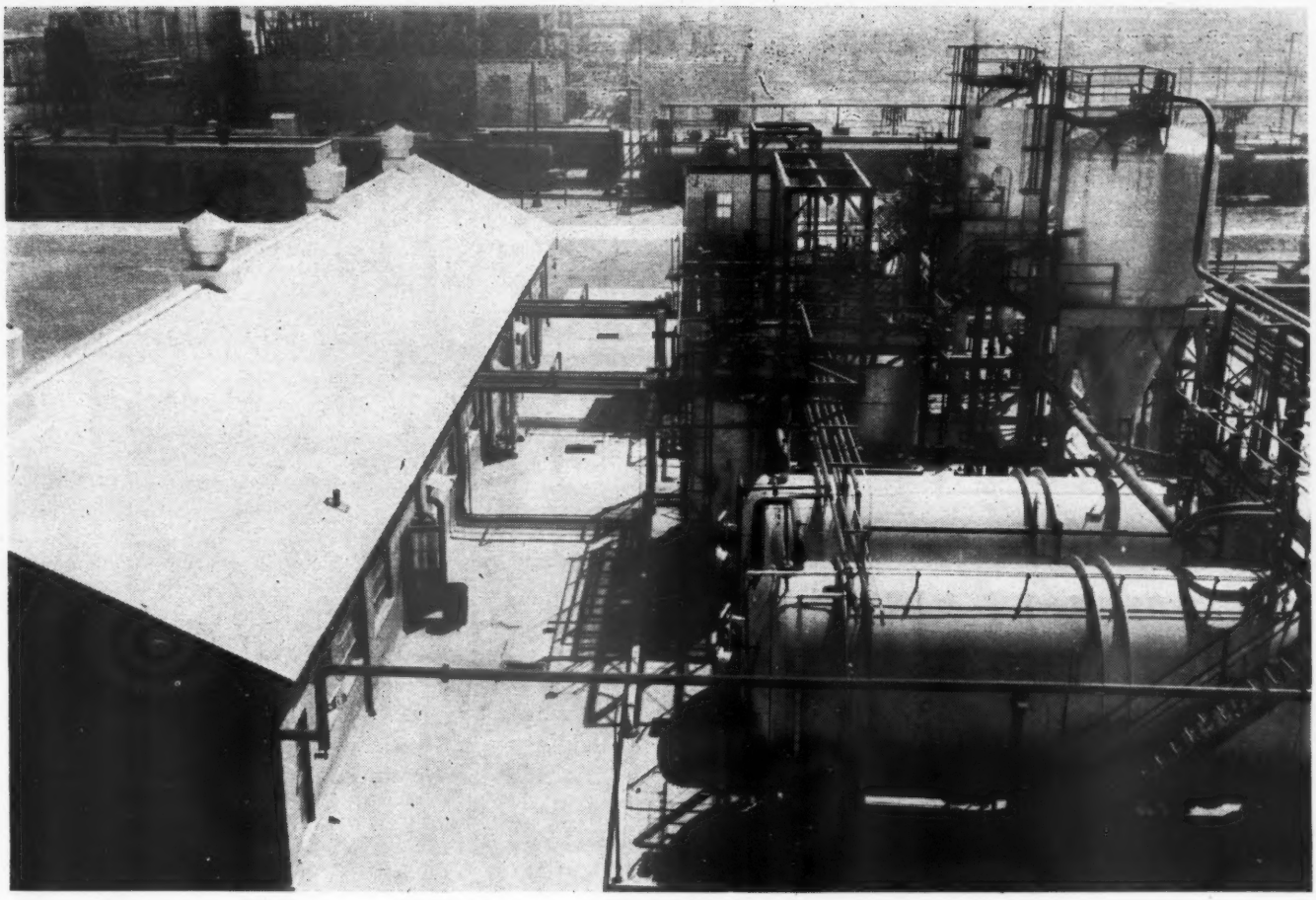
The small package room has empty drums which are delivered by an overhead conveyor from the empty package preparation shed at one end, and filled drums stacked in pallets at the other. At mid-point in the length of the room are electrically operated filling machines that are supplied from 3 ten-ton tanks overhead, and can fill 150 five-gallon drums or 500 one-pint containers per hour. For filling a lever is depressed to open the valves and when the drum, which is standing upon a scale, is full an electrical contact is made and the valve is closed. The 1-pint containers, which are truncated cones, are sealed in a special machine.

The barrel filling station is at ground level, and the barrels are delivered from the package preparation room by overhead conveyor to the filling machines, which have automatic electric weight control. Forty separate lines each carrying a different grade of oil are duplicated to the filling points on the 8 machines, and when full the 40-gal barrels are rolled on to a conveyor at floor level and transferred to the warehouse and the road and rail loading points. In the road tanker filling bay the road vehicles are automatically weighed before passing to the filling point, set below an overhead gantry, which carries the filling pipe line, and then weighed again when full.

The grease plant consists of 2 measuring tanks serving each autoclave, around which hot oil circulates at approximately 270 C, and this in turn flash discharges into 2 mixing kettles that are heated by steam at 80 psi and are cooled by water. The anhydrous mass in the kettle slowly cools to about 95 C when the grease is formed, and the balance of the mineral oil is added plus a dye. A penetrometer measures the penetration of the cone in units of 1/10 of a mm. Time allowed for penetration is 5 seconds, and the reading must be within $\pm$ 5 per cent of a given figure.

In the production of aluminium stearate greases static cooling is essential; otherwise the material will deteriorate into a mush, and also rapid cooling to maintain consistency. For the latter purpose a chilling and milling unit is employed consisting of two sets of water cooled rollers placed one above the other. Grease from the mixing kettle is pumped into side hoppers and passes as a thin film over the upper rollers where it is homogeneously cooled down to a steady rate from 140 to 40 C. Scrapers remove the grease film that falls into hoppers, where it ages before passing through the spring-loaded, water cooled. milling rolls from which it is scraped ready to flow into packages.

In the continuous closed method employed at Barton for producing lithium base grease a slurry of lithium stearate in oil passes through a tubular heater where its temperature is raised from 20 to 220 C. It is then fed through a dispenser on to a water-cooled stainless steel belt traveling at 200 ft per minute. After 30 ft of travel the layer of grease $\frac{1}{8}$ in. thick is scraped off. It is homogenized and passed through screens and a filter. Thus prepared lithium base greases have a melting point of 190 C and can function at a temperature approaching 50 C. The British jet plane Comet has found lithium base grease giving satisfactory performance at a ground temperature of 120 F and below zero temperature at 40,000 ft. In addition, the factory produces calcium base and sodium base greases, and others with additives like graphite, wool yarn, rubber latex, etc. * * *



View of north gasoline treating area showing two Linde sweetening units, McColl-Frontenac Oil Company.

New Sweetening Poly Units at Montreal

H. C. PLUMMER

THE past five years have been a period of marked expansion at the Montreal East refinery of McColl-Frontenac Oil Company Limited. In the period 1946-1948 the plant was built up to increase its capacity from 18,000 to 40,000 bbl per day. The expansion program is continuing. During the past two years the following units and processes have been expanded: Linde treating, catalytic polymerization, steam generating plant, transfer pumphouse, thermal reforming, vis-breaking, and pressure flashing.

In 1950 the company put into operation the largest Linde treating installation in Canada. The purpose of the Linde treatment is to enhance the marketing qualities of gasoline and other petroleum products by rendering them "Doctor sweet", which means that the products are free from mercaptan sulfur. "Sweetness" is a specification requirement of gasoline, solvents, kerosine and stove oil. The Linde treating process using copper chloride, oxygen and 200 mesh clay, converts malodorous mercaptan sulfur compounds into odorless disulfides.

Comprehensive Linde Formulae Call for Varied Vessels

The complete Linde treating process includes vessels for the following steps, (a) caustic washing to remove H_2S, (b) salt drying to remove excess water or caustic carried over, (c) slurry settling following the "sweetening" operation, (d) water washing to remove any trace of chemicals carried over from the settler, and (e) salt drying of the "sweet" product.

The sweetening process itself takes place when the sour gasoline stream mixes with a copper salt, clay, and oxygen at the eductor below the slurry settler. The copper salt and clay form a slurry with a controlled amount of water. The slurry is recirculated when it precipitates in the slurry settler. The slurry is made up using one part of copper chloride and 10 parts of 200 mesh clay mixed with naphtha to act as the liquid carrier medium.

In the treating process, following caustic washing and salt drying, a metered quantity of oxygen is injected into the hydrocarbon stream. The hydrocarbon stream passes through an eductor below the slurry settler, thus circulating the slurry continuously. The mixture of slurry, oxygen, and hydrocarbon leaves the eductor and enters the settler above its conical section. Flow rates are maintained to permit satisfactory settling of the slurry. The gasoline or other hydrocarbon leaves at the top of the settler.

The conversion of the mercaptans to

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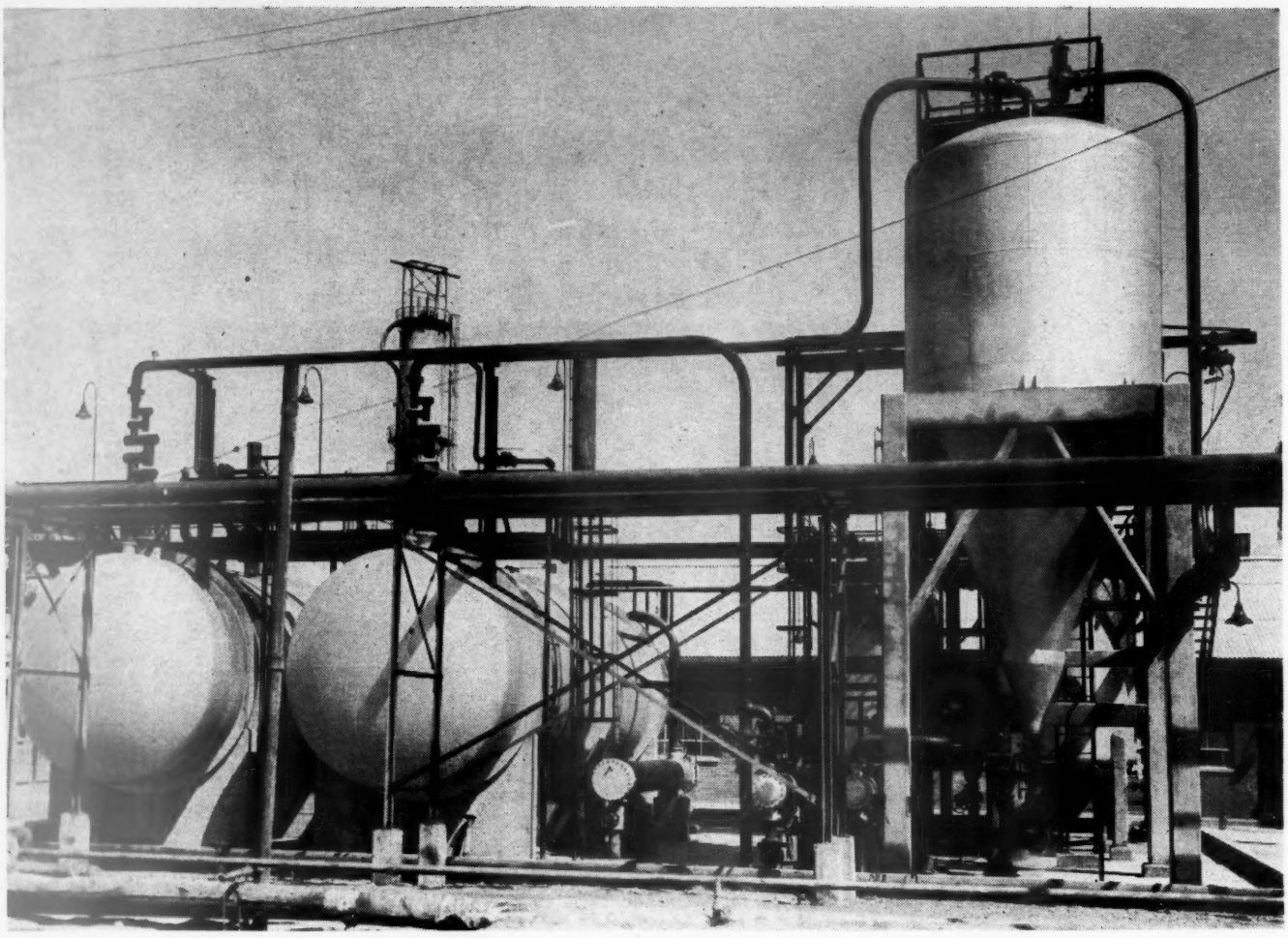

Closeup of sweetening unit, showing caustic wash, water wash, and slurry settling vessels.

disulfides takes place immediately following the mixing of the charge and slurry by the eductor.

The following equations illustrate the chemical process:

(a) Mercaptans are oxidized to disulphides while cupric chloride is reduced to cuprous chloride.

$$2CuCl_2 + 2R\text{–}SH \longrightarrow 2HCl + 2CuCl + R_2S_2$$

(b) The cupric chloride is regenerated by the action of oxygen on the cuprous chloride and hydrochloric acid.

$$\tfrac{1}{2}O_2 + 2CuCl + 2HCl \longrightarrow 2CuCl_2 + H_2O$$

(c) The overall reaction is as follows:

$$2R\text{–}SH\ (\text{Mercaptan}) + \tfrac{1}{2}O_2 \longrightarrow H_2O + R_2S_2\ (\text{disulfide})$$

Modern Design Highlights Attractiveness, Utility

The new treating unit comprises three complete Linde sweetening units, a light straight run gasoline treater of 12,000 bbl per day capacity, a cracked gasoline treater of 6000 bbl per day capacity and a kerosene and stove oil treater of 4000 bbl per day capacity.

The new treating unit is an example of good modern design highlighting utility, attractive appearance, and safety. All the pumps are conveniently located in the treater pumphouse in the center of the treating area. At the end of the treater pumphouse is the Control Room equipped with modern automatic control instruments. In the interests of safety, no hydrocarbons enter any of the control lines to the control room. Control impulses are transmitted pneumatically. Near the control room is a small laboratory where the operators run their own chemical tests on the treating operation.

In 1951 two new reactors were added to the existing four reactors of the catalytic polymerization unit thereby increasing its capacity of polymer gasoline production from 1000 to 1500 bbl per day. The two new reactors are of construction identical to that of the four others and the unit retains its symmetrical appearance. Each exchanger-type reactor is filled with 5200 lb of U.O.P. phosphoric acid catalyst. In 1951 stabilization facilities in the polymerization unit were improved by the installation of a larger capacity depropanizer. Commercial propane is produced meeting close specifications of purity, vapor pressure, and dryness.

Building Site Between Process Units and Major Tanks

To take care of increased refinery throughputs a new transfer pumphouse was completed in 1950. The building is conveniently situated between the process units and the major tank field. Facilities are provided for loading tank cars and tankers through manifolds of the pumphouse. Construction of the pumphouse was undertaken by the Moulton Company of Montreal and was designed by McColl-Frontenac engineers.

Present steam generating equipment in operation consists of three boilers each rated at 54,000 lb per hour steam at 250 psig and 500 F final steam temperature. A fourth boiler of 75,000 lb per hour capacity is being installed by Babcock, Wilcox Goldie, and McCulloch Limited of Galt, Ontario. The refinery staff is enlarging the steel frame brick boiler house to accommodate the new boiler.

In order to bring the capacities of the pressure flashing unit and the visbreaking unit into line with the overall increased throughput of the refinery, the flash towers of these two units have been replaced in the early part of 1951 by larger towers.

The thermal reforming unit charge capacity was increased during 1951 from 3400 to 4000 bbl per day. This was accomplished by installing additional tubes in the convection and radiant sections of the furnace and by replacing the fractionating tower with a larger vessel. * * *

New NON-LUBRICATED VAPOR-TIGHT PLUG VALVE

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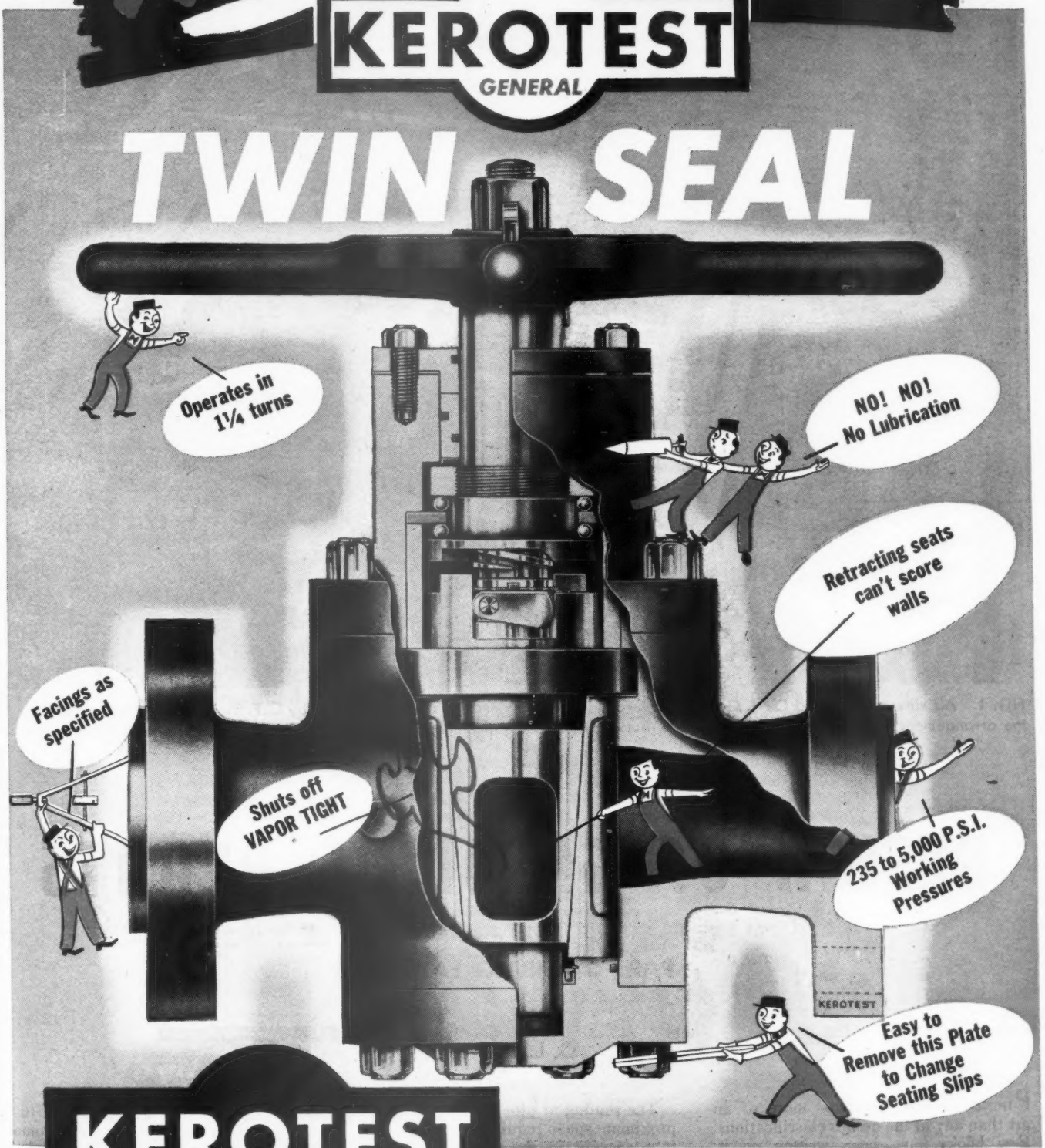
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FIG. 1. Air view of Stanolind Oil & Gas, Slaughter field plant. Engineering and construction by C. F. Braun and Company. Note the arrangement of pipelanes. Routing is direct, but access is not obstructed. Piers and stanchions are each used to an advantage.

DESIGN OF GASOLINE PLANTS

PART 3—PIPING LAYOUT

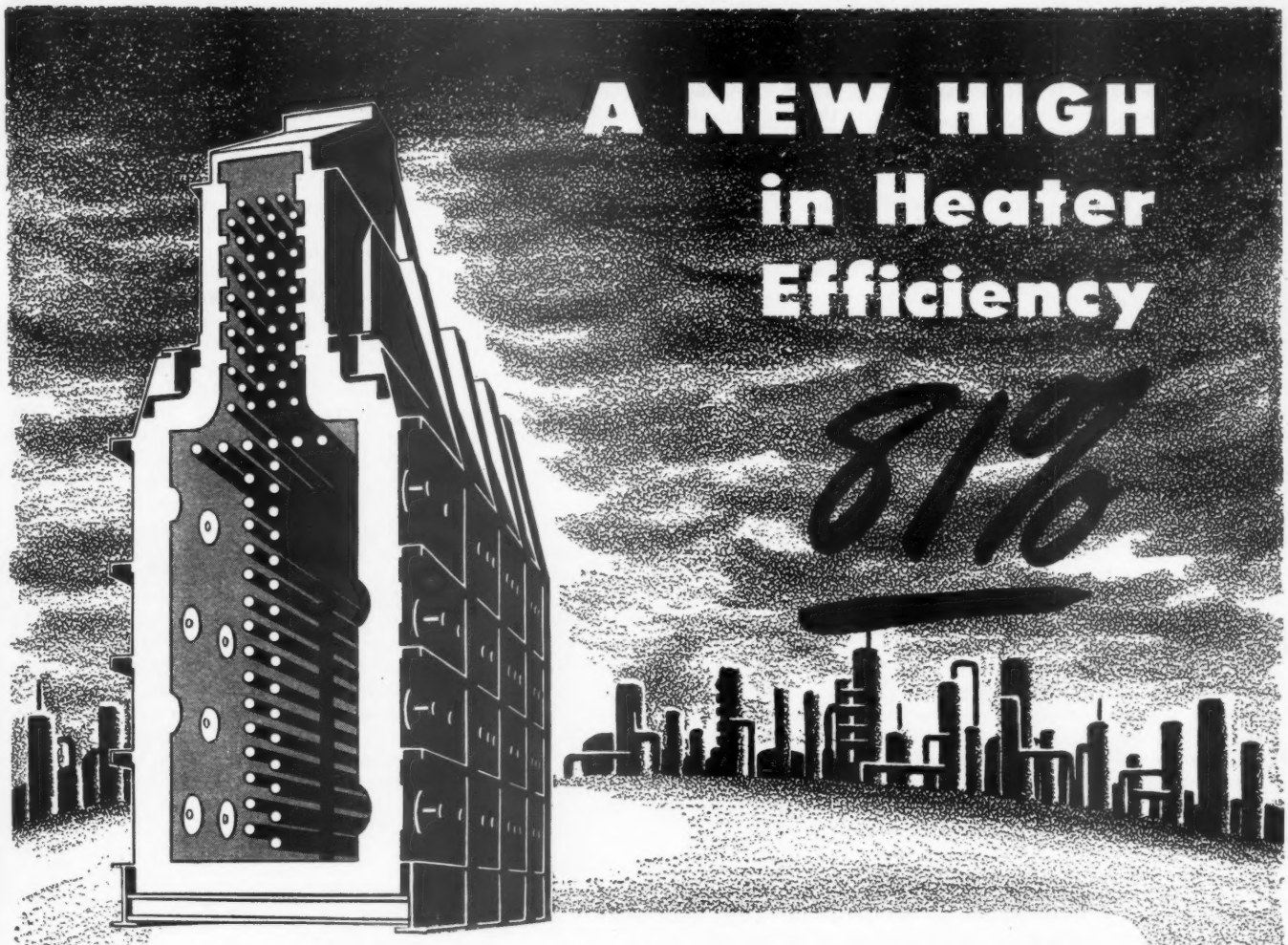
O. L. LEWIS

PIPING layout is perhaps more of an art than any of the design classifications. Few books have been written on it. Equations do not apply. It can be taught, but only by experience. It is always helpful to see and read about completed plants. Our mistakes show up there and after seeing them we can avoid making the same ones again.

The routing of pipe lanes and the approximate space required must be taken into account in the equipment-layout. The routing of the main lines should be established right along with the equipment location. A lot of attention is paid to the larger items — towers, buildings, etc. We look at this big equipment just as we look at the body of an automobile. Appearance is very important, but it is the motor that makes an automobile run. And a plant will not run without piping.

EXCLUSIVE

The elevation of piping is a part of layout. There are three general elevations. Underground, above ground on



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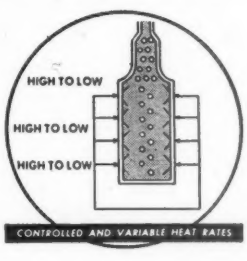

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piers, and overhead. Each arrangement has its own applications. We cannot say arbitrarily that all piping in a plant should be the same. It is essential that separate planes of elevation be established for lines at 90 deg to each other.

Underground

The early process plants in general used buried piping. Some of it was laid on top of the ground. Generally, no great attempt was made to group lines, or to use any geometric routing. Most old plant sites are honey-combed with rusted-out buried lines.

There are advantages to buried piping. Uusually the installation cost is low. The piping is out of the way and does not interfere with above-ground equipment or access ways. Covered lines are more uniform in temperature. Freezing is avoided in cold weather. Vaporization is avoided in hot weather.

Safety may be a point. A break in a buried line may not be as dangerous to equipment and personnel. Pump-suction lines may be buried to avoid vapor pockets. These are all important considerations.

Buried lines have disadvantages too; probably the most important is corrosion. Corrosion is nearly always accelerated when metal is buried. Low cost of original installation doesn't mean much when the pipe must be replaced frequently. Of course, protective coatings or cathodic protection may be used. In which case, the initial cost increases and that advantage is still lost. Leaks are hard to find. A leak in a product line can cost more in a few days than the installation cost of the entire line. Lines that operate at temperatures above 150 F, are subject to high stresses from forces of expansion. Line movement is difficult to provide for underground. Underground lines are difficult to locate and many times interfere with plant expansion and new construction.

Trenches

There is another way to retain most of the advantages of buried lines and avoid some of the disadvantages. When it is necessary that a line be below grade, a concrete trench may be the answer. Lines installed in trenches are accessible for inspection and alteration. Leaks can be located readily and repairs made more easily. Corrosion is usually not as severe and the pipe can be painted or maintained as required. Expansion can be guided, and stresses held within design limits.

Trenches are expensive. And that is the main disadvantage. Of course, in some locations they fill up with water unless an extensive drain system is provided. In others, they blow full of sand. And, in any case, they are hard to keep clean unless solid covers are used.

Piers

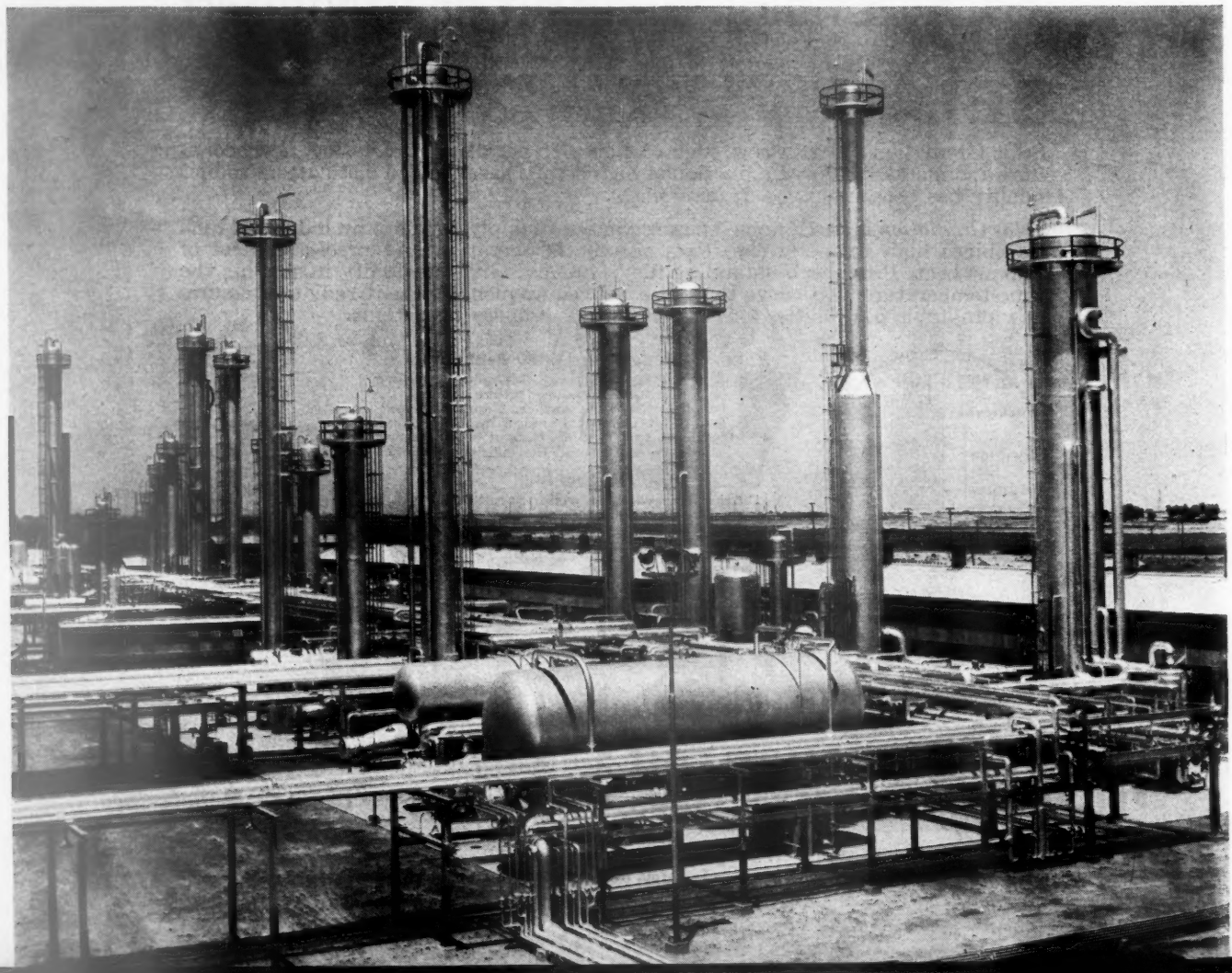
The most economical piping-installation is usually one where the pipe is supported on concrete sleepers just above the ground. The sleepers cost a little more per foot of pipe than ditching and backfilling. Welding and installation costs are cheaper than for either buried or overhead systems. Vibration and expansion can be controlled with tight anchors. Piping on piers avoids many of the disadvantages of buried lines and avoids the high cost of trenched lines.

Certainly, piping just above the ground is a road block too. Crossings must be provided for access for traffic. Steps are needed where walkways cross. Sometimes there is not room on the ground for piping.

Overhead

So if pipe rusts out underground and is a stumbling block on top of the ground, raise it up where our hats won't be knocked off. It is an advantage to place most piping overhead in a process area and around equipment. The lines are available for inspection, maintenance, and repair. Corrosion is minimized. Working areas are left unob-

FIG. 2. Partial plant view of Western Gulf Oil Company's Paloma plant. Engineering and construction by C. F. Braun and Company. The change in elevation with the change in direction of overhead-lines is plain. Note the uniform arrangement of vertical piping on the towers.



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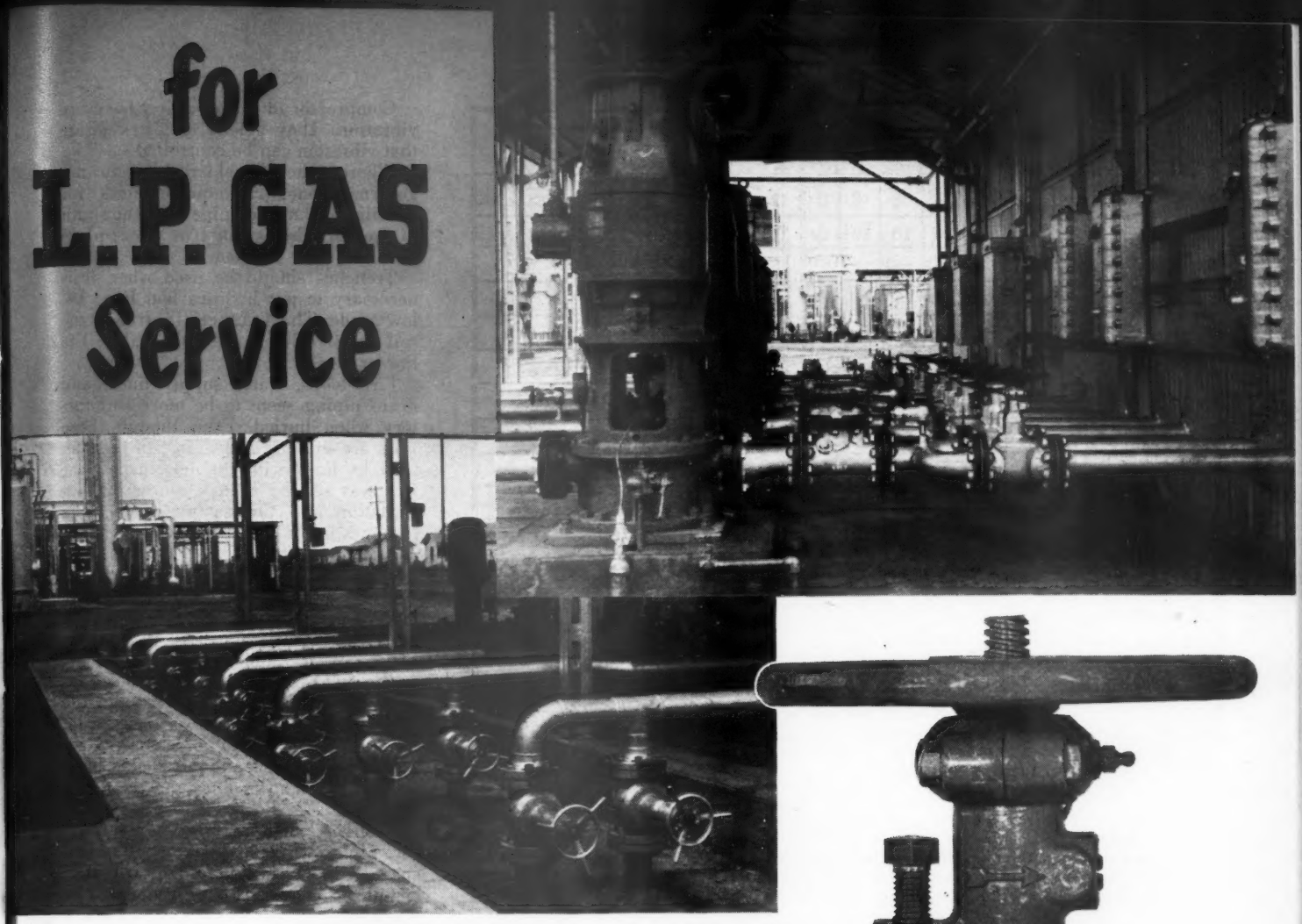

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SPACING ON PIERS																
			1½	2	3	4	6	8	10	12	14	16	18	20	24	Pipe Size, In.
1½	5		7	7½	8	9	10	10½	12	13½	14	15	16	17½	20	1½
2	5½	6½		8	9	9½	10½	11	13	14	14½	15½	16½	17½	20½	2
3	6	6½	7½		9	9½	11	12	13½	14½	15	16	17	18	21	3
4	7½	7½	8	8½		10	11½	12½	14	15	15½	16½	17½	18½	21½	4
6	9	9½	10	11	11½		12½	13½	15	16	16½	17½	18½	19½	22½	6
8	10½	10½	11	11½	12½	13½		14	16½	17	17½	18½	19½	20½	23½	8
10	12	12½	13	13½	14½	15½	16½		17	18	18½	19½	20½	22	24½	10
12	13	13½	14	14½	15½	16½	17½	18½		19	19½	20½	21½	23	25½	12
14	13½	14	14½	15	16	17	18	19	19½		20	21	22	23½	26	14
16	14½	14½	15	15½	16½	17½	19	20	20½	21½		22	23	24½	27	16
18	16	16½	17	17½	18½	19½	20½	21½	22	23	24		24	25½	28	18
20	17½	17½	18	18½	19½	20½	22	23	23½	24½	25½	26½		26½	29	20
24	20	20½	21	21½	22½	23½	24½	25½	26	27	28	29	31		31	24
Pipe Size	1½	2	3	4	6	8	10	12	14	16	18	20	24			

SPACING ON STANCHIONS

FIG. 3. Spacing of lines on pipelanes.

Spacing on stanchions is based upon 1-in. minimum clearance between larger flange and smaller pipe wall. The clearance is based upon 600-lb flanges through 12-in. size, 300-lb flanges 14-in. size and larger. Thickness of insulation, when required, should be added to space shown.

Spacing on piers is based upon minimum space required for hold-down clamps. The allowance is 5 in. for small lines, 6 in. for larger ones.

structed. Hot or cold insulated lines are easier to handle. Expansion can be cared for and bends or expansion joints installed as required. Leaks are obvious and repairs are easily made without excessive loss of time or material. Valve operation is convenient and pipe routing direct.

Again, support costs go up. Stanchions cost less than trenches but more than piers or ditches. The piping installation cost is higher than for lines on piers or in trenches. Stanchions cannot be considered firm anchors to the same extent that a concrete pier is. Lines subject to vibration should not be tied down to stanchions supporting other pipe. The vibration is hard to control and may be transmitted to other lines.

Choice of Elevation

When advantages and disadvantages of different methods of support are weighed, the piping falls into classes, and it is possible to set up the desired support-method in different plant areas.

Regardless of economics, piping in process areas will in general be overhead. The ground room is needed for operating space. Accessways must be kept clear of maintenance of equipment.

Compressor lines are subject to severe vibration. They belong on piers where that vibration can be controlled.

Where other considerations do not govern, economics indicate piers for established lanes of pipe from one unit to another. This is only true where plant access is not a problem.

Trenches should be used when it is necessary to put hydrocarbon lines below grade. This is especially true if the soil is corrosive or the material in the line expensive.

Fire loops, water supply lines, and drain piping seem to be more satisfactory when buried. Even though these lines are buried, it pays to run them in straight lines with 90 deg turns. The first cost may be greater, but ease of installation and time-saving in locating the lines in the future are well worth it.

Space Requirement

The space required for pipeways depends upon the number and size of lines involved. In early stages of piping layout the exact number of lines is usually not known and pipe sizes can be expected to change. At that stage in the game, a guide is needed to insure that enough space is available. See Fig. 1 for a guide to space requirements. Set down all the known lines and their estimated sizes. Allow normal space for these lines and add 50 per cent for future piping. Invariably, a portion of this space will be used before the plant is completed. The remaining room will be taken up by plant changes in just a few years of operation. Some excess space in pipe lanes is a part of planning for the future.

Pipe in a gasoline plant does not all run in one direction. Lines must cross and go up and down. The difficulty of pipe-crossings is another disadvantage to piping on piers. Cross-overs are expensive. Buried lines should be run at established depths. Otherwise, interference with sewers, electrical, or other buried services is to be expected. Overhead lines must be run at established elevations too. Different elevations for lines running in different directions will avoid interference now and in the future. Even airplanes fly this way and they have a lot more room to get around in than most piping.

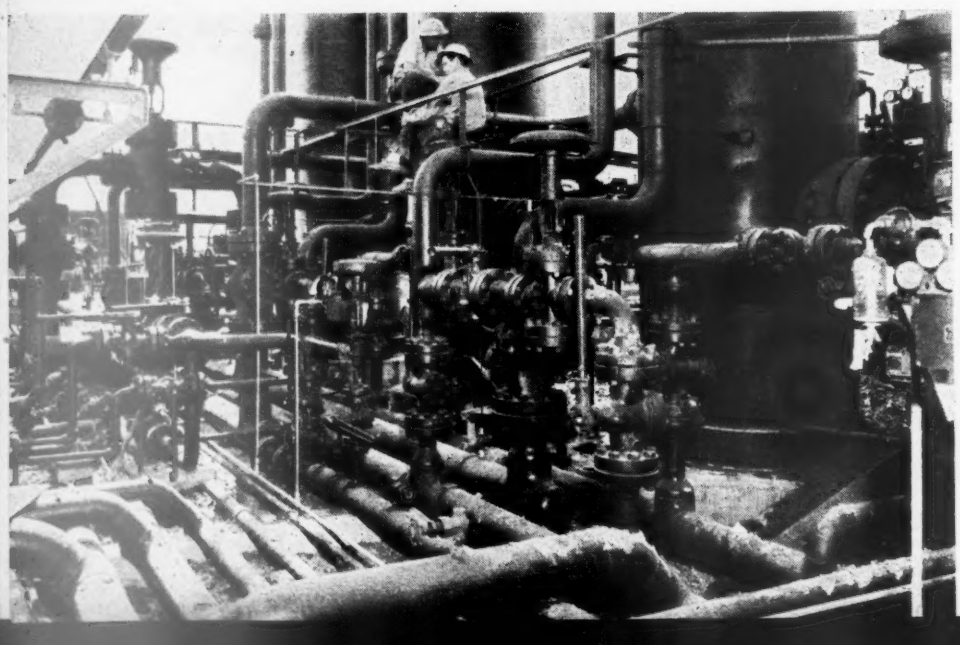


FIG. 4. An arrangement of valving and controls at three high-pressure absorbers. The construction was ahead of design on this plant and the absorber foundations were poured too close together before piping-layout had developed enough to establish the need for additional room. This installation is an operator's nightmare. Note the pipe-fitter's expression as he looks over the jungle and the undergrowth.

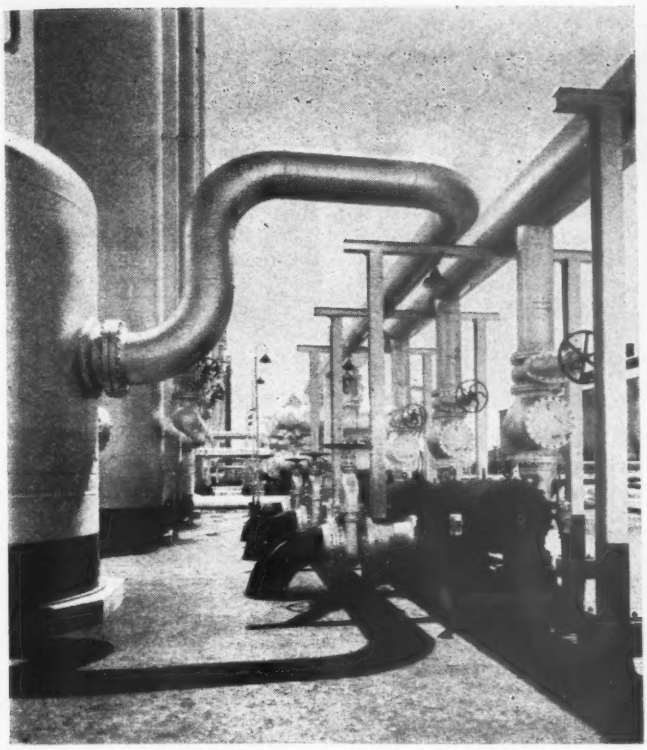


FIG. 5. Jacket-water pumps. Note the spool pieces between pump and check valve on the discharge and the eccentris reducer, belly down on the suction-line.

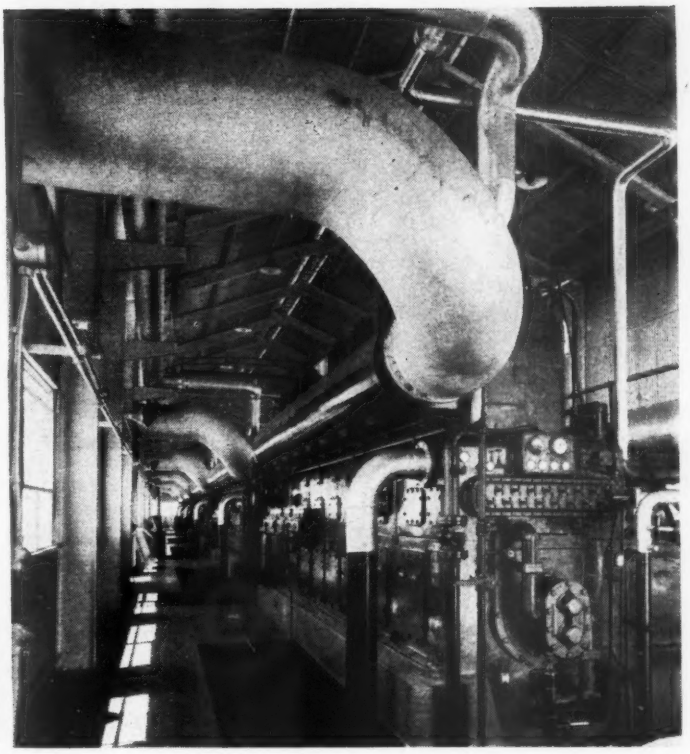
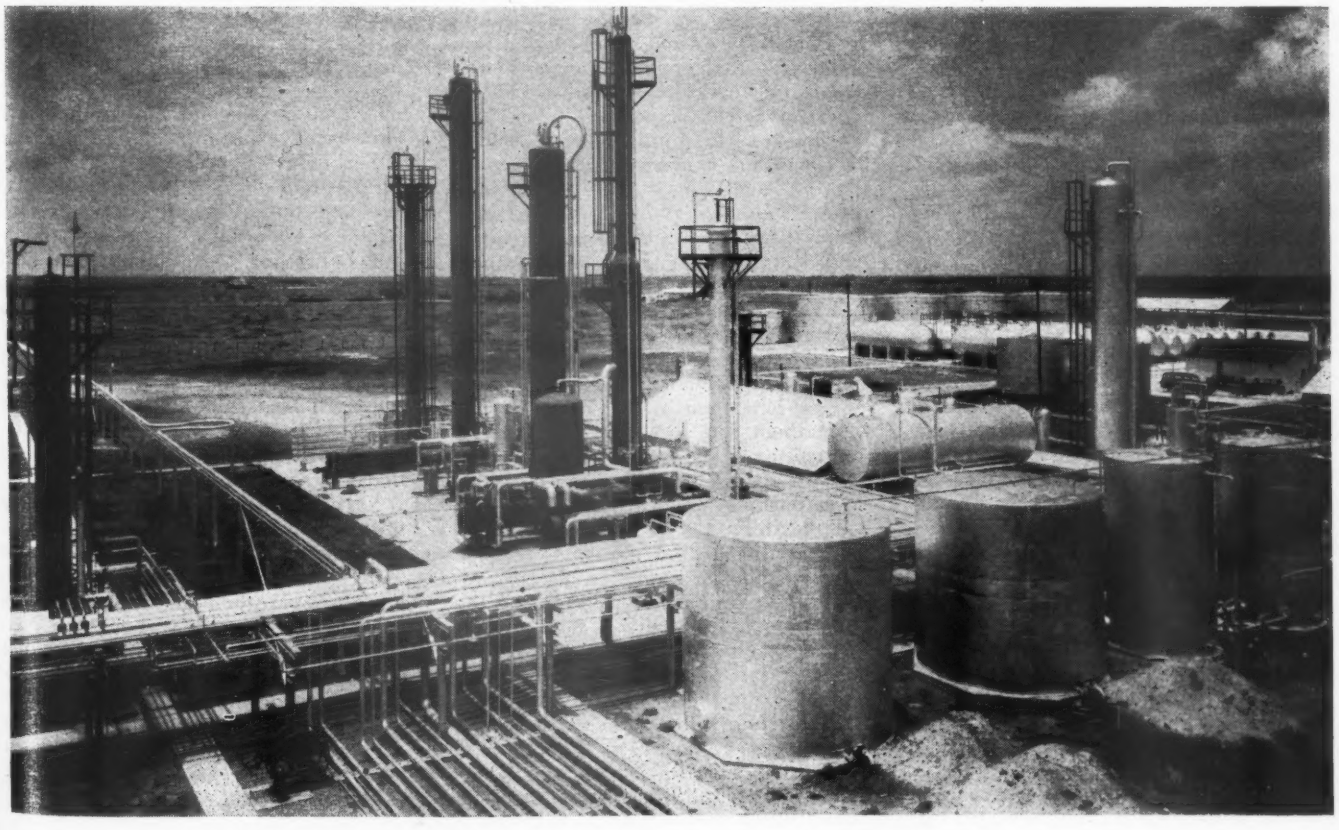


FIG. 7. End view of a gasoline plant compressor installation. Note clean appearance behind units. Exhaust-lines, cooling-water, starting-air, and fuelgas are all held close to the unit and grouped for convenience.

FIG. 6. A partial plant view showing the transition from piers to stanchions, also note that valves on top of exchangers are in the horizontal and that the spool between valve and exchanger can be easily removed for exchanger-maintenance. The valves in the lines from the bottom of the exchangers are up at easy operating height.



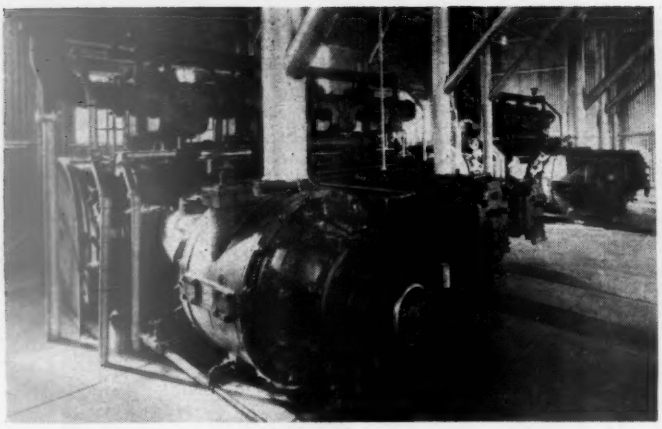


FIG. 8. One of the first highspeed, highpressure compressor installations. Note bracing on suction-lines, added in an attempt to control vibration.

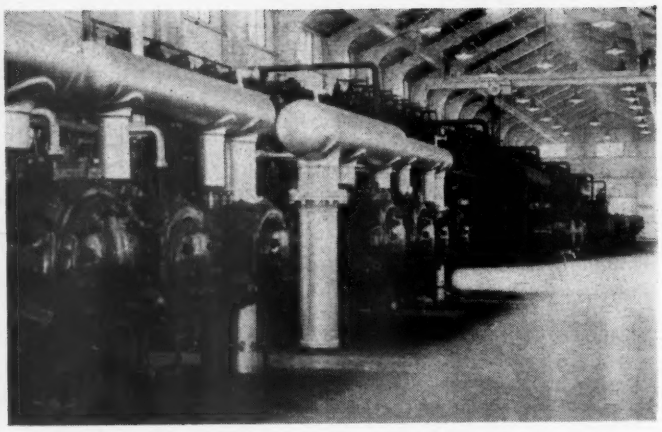


FIG. 9. A modern type compressor installation with both suction and discharge lines under the floor. No trouble with vibration in this plant.

In setting up the elevations to be used for overhead piping, the height of the homo sapien is all important. The lowest lines must be high enough for head clearance. A West Texan with a hat on, ready to tell a tall story, can just make it under a line that is 7 ft 0 in. from grade to bottom of pipe. Valves in that 7-ft line can be reached for operation too. Lines at this elevation would be laterals from towers to pumps, pumps to pipe lines, etc. If 7 ft is used for north-south lines, and 10 ft for east-west ones, interference will be avoided. With this assumption as a starter, pipe can be stacked on up as high as space requires. If laterals are 7 ft, then the pipe-lane perpendicular to the laterals could be 10 ft and lanes parallel to the laterals 12 ft, etc. More than 3 ft difference in elevation may be needed if lines are large. If many lines are larger than 10-in. size, additional room is needed.

Usually it is more economical to hold stanchion-heights down to minimum clearances in general areas, and provide crossovers where major access-roads require them. Lower supports are cheaper and installation of low-piping is less expensive.

Arrangement of Lines

A major part of piping layout work is the arrangement of lines in the lanes. Avoid crossovers within the pipe lanes. Normally, it is good practice to place the larger headers nearest the equipment. The larger laterals are then shorter in length, and pipe tonnage is reduced. Steam headers and hot transfer lines take the outside position. Expansion loops are often necessary in these lines and they are provided more easily if the layout takes them into consideration early.

Frequency of Flanges

Refinery piping is often set up with flanges or joints at 20 to 40 ft spacing regardless of installation requirements. These joints are necessary in a line that may need frequent cleaning, or that is handling corrosive materials such that sections of the line may need to be replaced.

The normal gasoline plant has neither of these problems. Flanges are required only for construction purposes or removal of valves or equipment. Overhead lines will normally require flanges only at valves and equipment and at lateral takeoffs. Flanges are not so expensive, but lining them up, welding them on, and maintaining tight joints in operation, all add to the overall cost.

Allowance for Flexibility

The prime object of layout is to get the piping to and from the equipment, arranged in a logical order, economically, and in a manner not detrimental to the appearance of the plant. Following only these guides we would tend to follow straight lines as far as possible.

Temperature and expansion now enter into the picture. If expansion is not cared for in the original layout, expensive bends, expansion-joints, and anchors will be required later.

The simplest means of absorbing expansion and stresses due to temperature is the plain L bend. Good layout using this bend as a component, reduces both length of pipe required and expansion problems.

Expansion cannot be neglected in so called "cold lines." A piece of pipe exposed only to air temperatures will vary 100-deg from summer to winter. A line 1000-ft long then will expand and contract about 7 in. just from this temperature change. The force exerted is 106,000 psi of wall area. We can't have this force pushing things around, so we provide flexibility.

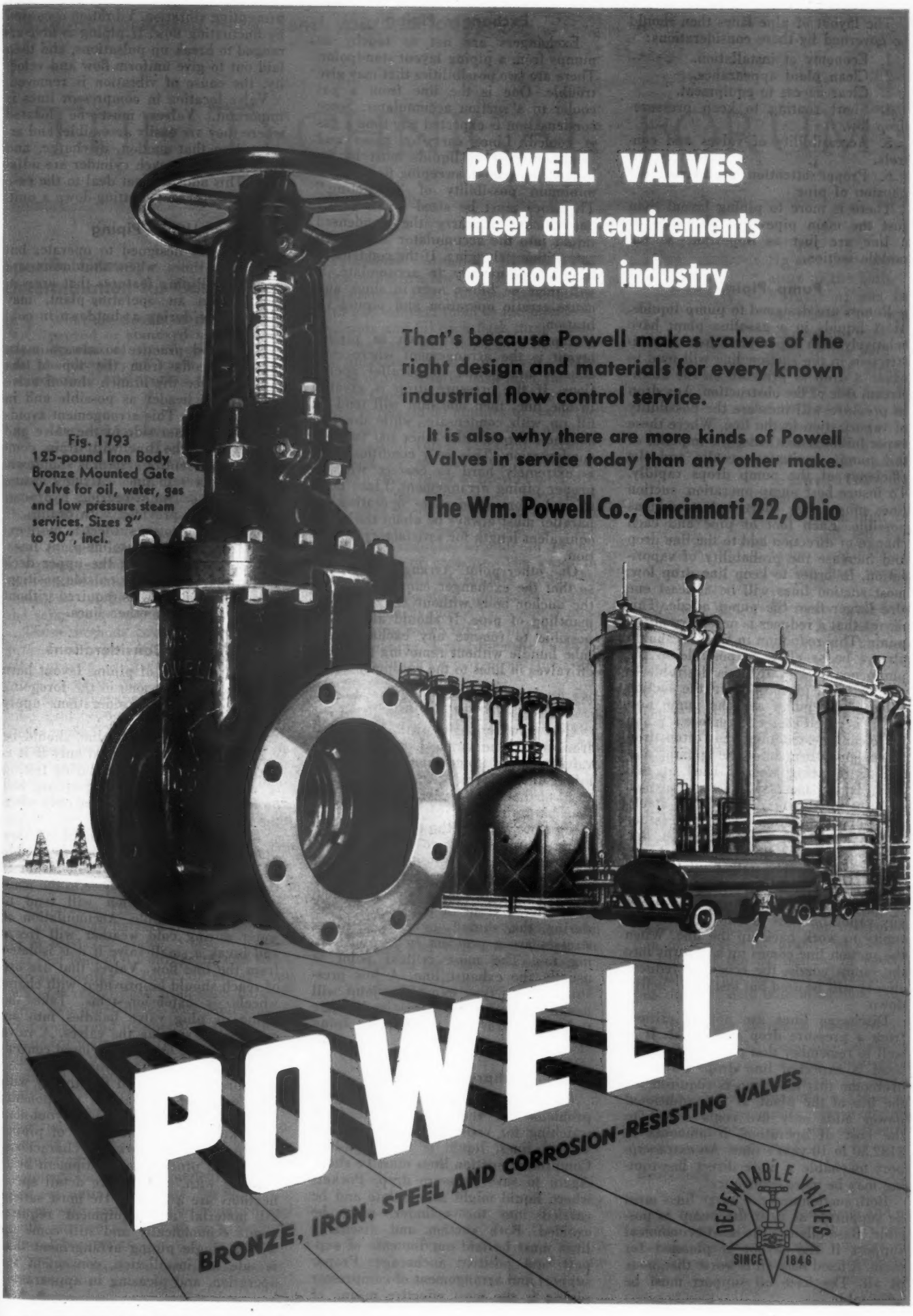
Flexibility is the ability to change shape without breaking. If offset is provided, less force is required to bend the pipe than to compress it. The amount of offset then must be sufficient to allow the necessary change in shape without over-stressing the pipe at any point.

Watch four things: (1) regardless of operating-temperature, all lines are subject to temperature difference; (2) expansion and resulting forces must be taken into account in piping layout, (3) never anchor two points of any line without some means of caring for expansion; (4) the most economical way of absorbing expansion is with pipe itself in simple bends as a part of piping layout.

One more point on the expansion bug-a-boo. Piping connections to some rotating equipment are critical. Undue or accelerated wear and failure of pumps and turbines often can be traced directly to excessive piping-stresses. Expansion joints are not always the answer. The force of the joint reaction may exceed the force of the piping without the joint. Planning in layout and arrangement of piping can do more to alleviate piping stresses than any other approach.

Pump and turbine manufacturers sometimes specify that no piping stresses be imposed upon the equipment. This is impossible in actual practice. And it is not usually a requirement for satisfactory operation of the equipment. The piping designer can either ignore the unrealistic manufacturer's request completely, or try to evaluate the allowable stress on the equipment himself. This places an undue burden on the designer. The only answer at the time being is to design end piping stresses at equipment to a practical minimum. If the point is critical, check it with the manufacturer. If he still objects, ask for calculations on the equipment that show the deflection expected from the contemplated forces. Usually a compromise can be reached that will be satisfactory to both parties.

Vertical lines expand too, but the towers may go up faster than the pipe. Lines hotter than the tower must have loops or sufficient horizontal run to allow bending without overstressing. Lines colder than the tower should be supported at the takeoff from the tower and left loose or spring-supported at the bottom so the upward movement is allowable. Attention to the relative location of the line in the pipe lane will often provide the necessary horizontal run for deflection without over stress.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The layout of pipe lanes then should be governed by these considerations:

1. Economy of installation.
2. Clean plant appearance.
3. Clear access to equipment.
4. Short routing to keep pressure-drop low.
5. Accessiblility of valves and controls.
6. Proper attention to thermal expansion of pipe.

There is more to piping layout than just the main pipeways. The ends of a line are just as important as the middle section.

Pump Piping

Pumps are designed to pump liquids. Most liquids in a gasoline plant have relatively high vapor pressures. Any restriction in the suction line will tend to cause a drop in pressure on the downstream side of the obstruction. Any drop in pressure will increase the possibility of vaporization in the line. Where these vapor bubbles then enter the impeller of the pump, cavitation results and the efficiency of the pump drops rapidly. To insure best pump operation, suction lines must be as short and straight as possible. Each foot of pipe and each change of direction add to the line drop and increase the probability of vaporization. In order to keep line drop low, most suction lines will be at least one size larger than the pump nozzle. This means that a reducer is necessary at the pump. This reduction in line size should always be as close as possible to the pump nozzle. Usually it is desirable to have a spool piece between the suction valve at the pump and the pump nozzle. It is much easier to remove a pump for clearance. Suction lines often drop down and turn into the pump nozzle. A reducing weldell used at this point is the most satisfactory answer, both economically and from a standpoint of vaporization. If it is necessary to use a welding reducer and a line size weldell the reducer should always be eccentric and installed "belly" up. This arrangement provides smoother fluid flow around the turn, and gives any vapor bubbles that form an opportunity to work back up the line. When the suction line comes up and turns into the pump nozzle, the eccentric reducer should still be used but installed "belly" down.

Discharge lines are not as critical from a pressure drop standpoint. It is well to remember that part of the pump head is expected line drop. Power to overcome this line drop is required for the life of the plant. If this additional power adds only five cents a day to the cost of operation, it amounts to $182.50 in 10 year's time. An extra support to enable a more direct line-routing may be more economical.

Both suction and discharge lines must be supported as near the pump as possible. Base ells are the most economical support if the layout is planned for them. A fixed base ell is worse than none at all. The base ell support must be adjustable.

Exchanger Piping

Exchangers are not as touchy as pumps from a piping layout standpoint. There are two possibilities that may give trouble. One is the line from a gas cooler to a suction accumulator. Some condensation is expected any time a gas is cooled. Lines carrying gases and small amounts of liquids must be arranged for smooth sweeping flow with a minimum possibility of "pocketing." The lines must be sized for sufficient gas-velocity to carry the condensed liquid into the accumulator at an even rate without slugging. If the condensate has an opportunity to accumulate, it will then be blown over in slugs and cause erratic operation and piping vibration.

Another point to watch in piping layout is the arrangement where condensers are paired in parallel operations. If the pressure drop is greater in one line, then one unit will tend to fill up with condensate, while the gas channels through the other too fast for condensation. This is a condition that is extremely hard to correct without proper piping arrangement. Lines both to and from condensers operating in parallel must always be about the same equivalent length for satisfactory operation.

One other point. Arrange the piping so that the exchanger can be lifted off the anchor bolts without excessive dismantling of pipe. It should always be possible to remove any exchanger or tube bundle without removing the shutoff valves in lines to the equipment.

Turbine Piping

One problem in piping to and from a turbine is condensate. Shutoff valves at the turbine should be horizontal. A small drain valve is required in front of the shutoff valve. The lines can then be drained entirely of any condensate before starting the turbine. If automatic control is used to start a turbine under emergency conditions with no operator present, the control must be situated so that condensate cannot accumulate in front of the control valve during the shutoff periods. Piping stresses are a problem in turbine piping too. The most critical point is usually the exhaust line. A low pressure bellows type expansion joint will usually reduce nozzle stress and isolate turbine vibration from the piping system.

Compressor Piping

Compressors present a set of piping problems all their own. Instead of watching for vapor traps, as in pump suction lines, liquid is the bug-a-boo. Compressor suction lines must be short. Again to save pressure drop. Pockets where liquid might accumulate and be carried into the cylinder, must be avoided. Both suction and discharge lines must be laid out for ease of support and positive anchorage. Proper support and arrangement of compressor piping is the most effective means of preventing vibration. Vibration is caused by fluctuating flow. If piping is first arranged to break up pulsations, and then laid out to give uniform flow and velocity, the cause of vibration is removed.

Valve location in compressor lines is important. Valves must be located where they are easily accessible, and arranged so that suction, discharge, and bypass-valves to each cylinder are adjacent. This adds a great deal to the ease of starting-up and shutting-down a unit.

Utility Piping

A plant is designed to operate, but there are times when shutdowns are necessary. Piping features that are satisfactory in an operating-plant, may give trouble during a shutdown in cold weather.

It is good practice to always make utility takeoffs from the top of the header. Place the branch shutoff valve as near the header as possible and in the horizontal. This arrangement avoids pockets on either side of the valve and insures that the line will drain completely if the entire system is shutdown. All low places in lines carrying steam, water, air, or water-bearing hydrocarbons must be provided with drains.

Steam-headers are subject to more expansion than most gasoline-plant lines. If they are located on the upper deck of the pipe-lane, in the outside position, loops can be spaced as required without interference from other lines.

General Considerations

Most problems of piping layout have been mentioned in one of the foregoing categories. Some considerations apply equally to all categories.

Every high point in a line should be vented. A valve is required only if it is necessary to vent the line during testing or operation. A plugged coupling will do if the vent need be opened only when the line is shutdown.

The same thing is true of all low places in lines. It is necessary to be able to drain every pocket. If the drain is valved, place the valve close to the main pipe. Normal vibration will tend to break a long nipple. Accumulation of water during cold weather will freeze and break a small valve if it is isolated from the line flow. Valves that are out of reach should be provided with chain-wheels or extension-stems. Take the swing of plug valve handles into account when spacing the valves. A valve that cannot be opened or closed conveniently is of no use to anyone.

Piping-layout is tied in directly with the design of the various components of the piping systems. The layout-man must know the requirements of piping design. He must know the characteristics of the process and equipment he is working with, even before detail specifications are available. He must satisfy all material and equipment requirements economically and still come up with a single piping arrangement that is safe for installation, convenient for operation, and pleasing in appearance.

* * *

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THE TECHNICAL FORUM

Specific Gravity Determination for Gases

Q What are details of the most approved or standard methods for determination of the specific gravity, and the density, of gases and vapors for practical engineering purposes?
H. K. G.

A Methods for determining the specific gravity of gases including liquefied petroleum gases in gaseous state at normal temperature and pressures are sufficiently varied in nature so that one or more of the methods described may be employed for laboratory, control, reference, or in fact for any purpose where it is desired to know the relative density of a gas or gases as compared to the density of dry air at the same temperature and pressure.

These methods cover three approved procedures* for determining the specific gravity of gases using different types of apparatus, and are based on the assumption that gases tested for specific gravity do not deviate from the fundamental laws governing the temperature and pressure relationships of ideal gases. This assumption can be made because, within the range of temperature and pressures used in the measurement of specific gravity of gases, any such deviation is negligible in its effect on specific gravity.

Direct Weighing Method

Apparatus. The apparatus consists of an analytical balance with a capacity of at least 250 grams, a sensitivity under that load of 0.1 milligram, and room for suspending a 1-liter or at least an 0.5 liter round flask from each balance arm, two glass flasks with well-ground stopcocks, and connecting tubes with standard male ends (the flasks must be closely matched in form, weight, and volume). A thermostat capable of maintaining a temperature constant to 0.01 C in a bath with room for the two flasks mentioned above and facilities for supporting and connecting them and manipulating their stopcocks, facilities, and connections in a permanent manifold for evacuating the flasks, for supplying them with sample to be weighed and with purified air and an accurate mercurial barometer.

*A.S.T.M. Standards, 1949, part 5, pp 1381.

Procedure. Adjust the thermostat to a temperature a few degrees above room temperature. Place the two flasks in the bath and connect them to the manifold. Evacuate and fill each flask three times. Fill one flask with the gas to be tested and the other with dry air. Leave a slight excess of pressure in flask after the last filling. Close the valves and allow the bulbs to remain 30 minutes to reach the temperature of the bath; then arrange the manifold valves to permit purging gas and air to the outer atmosphere through small tubes to prevent back diffusion. After these tubes have been purged with the sample gas and with air respectively, open the valves of the flasks for about 5 seconds to permit equalization of pressure. The gases in the flasks will be slightly chilled by expansion, possibly unequally. Again leave the flasks closed for about 5 minutes, during which time record the barometric reading. Again open the flasks to the atmosphere for one second and close the valves.

Remove the flasks from the bath and clean them; then hang them in place on the balance and leave for 30 minutes to attain the temperature of the balance case. In dry weather, static charges may give trouble. If they do, the flasks should be exposed momentarily to steam from boiling distilled water before hanging in the balance. After the flasks have been in the case for 30 minutes, bring the balance to equilibrium by adding weights to one side or the other.

Repeat the procedure exactly as before except that the flask that formerly contained air now shall be filled with sample gas and vice versa. Weigh the same flask on the same balance pan.

Calculations. Calculate the specific gravity of the gas by means of Equation 1.

$$\text{Specific gravity} = \frac{Dg}{Da} = \frac{P_2V_1 + P_1V_2}{P_1V_1 + P_2V_2} + \frac{(W_r - W_L)\,1 + (W_L - W_r)\,2}{P_1V_1 + P_2V_2} \times \frac{760}{Da} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Where V_1 = Volume of gas in bulb 1 at 760 mm Hg and the temperature of the bath.

V_2 = Volume of gas in bulb 2 at 760 mm Hg and the temperature of the bath.

Da = Density of air at 760 mm Hg and at temperature of bath.

Dg = Density of gas at 760 mm Hg and at temperature of bath.

W_{r_1} and W_{L_1} = Weights added to right and left pan to produce balance during first weighing.

W_{r_2} and W_{L_2} = Weights added to right and left pan to produce balance during second weighing, and assuming Flask 1 is filled with sample gas and weighed on the left pan the first weighing and that Flask 2 is filled with sample gas and weighed on the right pan the second weighing.

Application. This method is to be used for determinations requiring exceptional accuracy and for determination of the specific gravity of gases to be used for the calibration of specific gravity instruments. This method is not practical for field determinations.

Pressure Balance Method

Apparatus. The apparatus consists of an Ac-Me gravity balance (four-spring type), tripod, manometer, air dryer, pump and hose connections. (It is not intended to imply that there are not other equally accurate and satisfactory instruments available.)

Procedure:

A. Setting up.

1. Set up tripod in the shade and out of the wind, if possible. If on sloping ground, loosen wing nuts on legs and adjust so that base is approximately

level, tighten wing nuts, and tighten thumb screw on spider. If tripod is set on loose, sandy ground, boards should be put under tripod legs.

2. Lifting instrument by case, screw onto tripod. Unhook and remove case using it as a stool during test. Level instrument with leveling nuts (Bc 15) and lock with wing nuts (Fig. 1) underneath base board.

3. Attach manometer by bracket to baseboard. Attach hose connecting manometer to 3rd valve on instrument and open valve. Be sure that bonnett on valve is pulled down tight to prevent leaks. Fill manometer with mercury to zero.

B. Taking readings.

In testing the specific gravity of a gas, four readings should be made and recorded: (1) Average barometer reading, (2) air reading, (3) gas reading, and (4) air check reading. These readings should all be made with the gravity balance in exactly the same adjustment and same position. The temperature in the balance should be observed for each of readings (2), (3), and (4).

1. Average Barometer Reading.

Read the aneroid barometer at the beginning and at the end of each test, recording on the report sheet the average of these two readings (or, read barometer at the end of air and gas readings).

2. Air Reading.

a. Attach hose connecting fourth valve to vacuum side of pump (Fig. 1) and pull to about 650 mm vacuum; close fourth valve.

b. Attach hose connecting first valve to top connection of air dryer (Fig. 1) and admit air through the dryer into the balance until atmospheric pressure is reached. Close first valve.

c. Open fourth valve and pull a vacuum of about 650 mm then close fourth valve. Unlock the balance beam by turning locking lever counter-clockwise; the beam will then be in an unbalanced position with the zero above the hairline indicator. Admit air through first valve and air dryer until the beam reaches the balanced position. The balanced position is best determined by noting the swing of the beam; when the zero swings an equal number of divisions above and below the hairline, the beam is in balanced position. Air may be admitted rapidly at first but as the balanced position is approached, the first valve should be pinched down so that the air can be cut off at exactly the right instant to keep the beam in the balanced position. Lock instrument, read, and record the air vacuum shown on the manometer. If the air reading is to be had under a pressure, the beam would be in an unbalanced position with the zero below the hairline; air would then be released from balance through second valve and beam brought to balanced position in a similar manner to that outlined above. Keep instrument locked except when it is being balanced.

3. Gas Reading.

I. For gas under pressure.

a. Close cocks on air dryer and detach hose from same, then open fourth valve and pull a vacuum on the balance of about 650 mm (Fig. 1).

b. Attach hose connecting first valve with gas supply (Fig. 1) and admit gas into the balance until pressure reads 650 mm.

c. Repeat (a) and (b) three times. The first time leaves about 8 per cent air in the balance. The second time leaves about 8 per cent of the 8 per cent mixture or .64 per cent air. The third time leaves about 8 per cent of the .64 per cent mixture or .05 per cent air, which would result in an error so small that it is negligible. If the balance is purged by blowing gas through it, the purging should be continued until two successive readings (see Sec. "d" below) will check.

d. Unlock instrument and release gas pressure through second valve until balanced position of beam is reached. Lock instrument, read, and record gas pressure shown on manometer.

II. For gas under vacuum.

When making a reading on gas under vacuum and having a high content of natural gasoline, it is important to have the pressure within the balance as nearly as possible equal to that in the line and never at a higher absolute pressure than that in the line.

a. Adjust instrument to balance on gas at a vacuum of about 20 mm higher than that in the line. Attach hose connecting first valve to gas supply, then attach pump vacuum, and hose connecting pump pressure to gas supply (Fig. 1). In cases of extremely high vacuum it will be necessary to use a motor-driven pump instead of the Ac-Me hand pump.

b. Open fourth valve and first valve; then, by means of the pump, pull gas through the balance, purging it until two successive readings (sec. "C") will check.

c. Close first valve and pull as high a vacuum as possible on the balance. Close fourth valve; unlock instrument and admit gas into the balance through first valve until the beam reaches the balance position. Lock instrument, read, and record gas vacuum shown on manometer.

4. Air Check Reading.

a. Disconnect hoses connecting balance to gas supply (Fig. 1). Open fourth valve and pull a vacuum of about 650 mm.

b. Attach hose connecting first valve to air dryer (Fig. 1) and admit air through the air dryer into the balance until atmospheric pressure is reached. Close first valve.

c. Repeat "a" and "b" at least three times or until two successive readings (see sec. "d" below) will check.

d. Open fourth valve and pull a vacuum of about 650 mm then close fourth valve. Unlock instrument and admit air through first valve to bring the beam to the balanced position as when taking the first air reading. Lock instrument, read and record the air vacuum shown on manometer. This is a very important check on the accuracy of the test and requires no extra time as the instrument

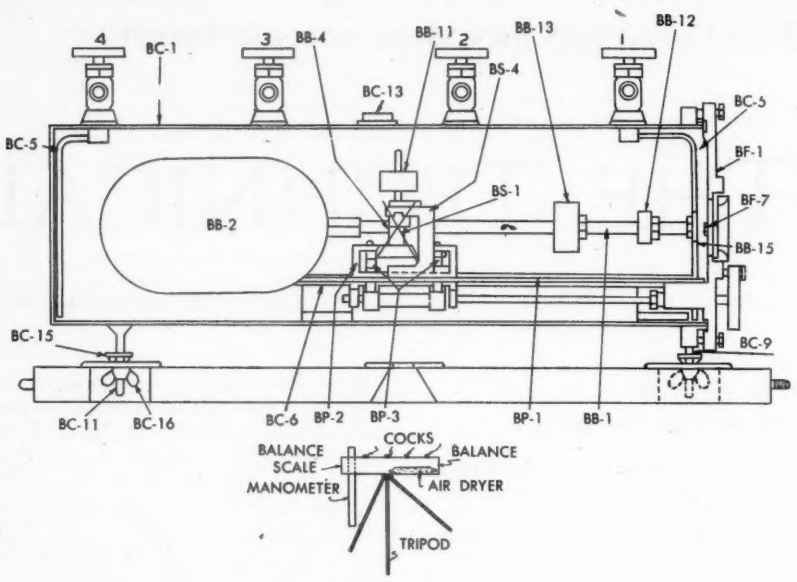
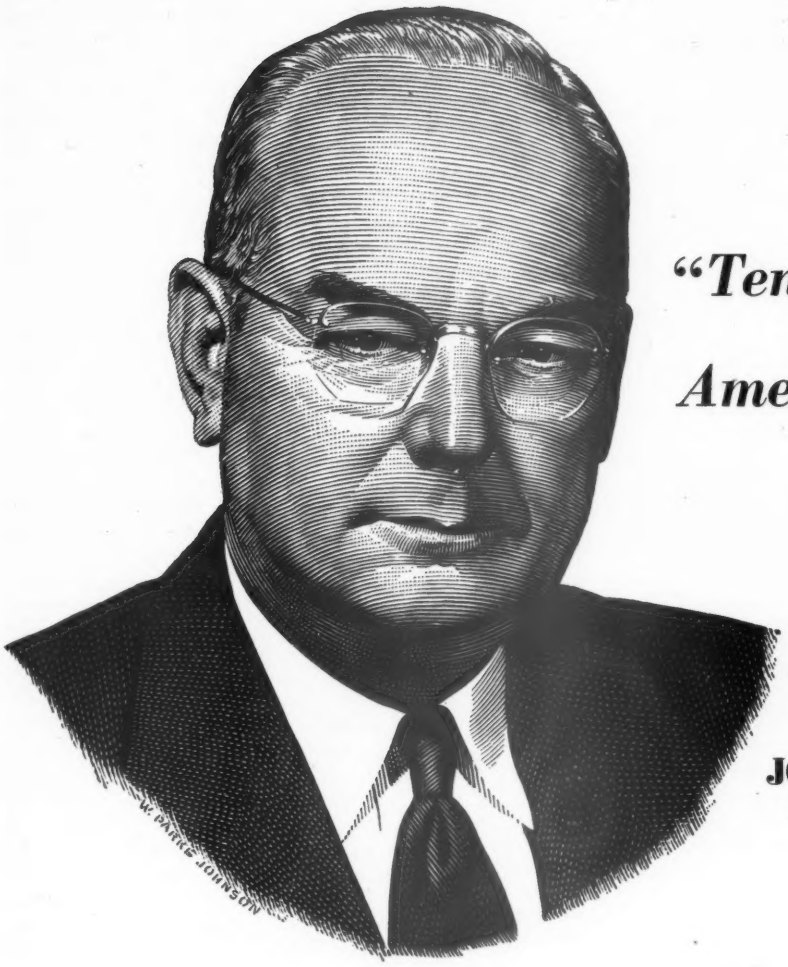


FIG. 1. 1-2-3-4 valves.

BF-1	Face	BC-1	Container
BF-7	Hair-line indicator	BC-5	Purging ring
BB-1	Balance beam	BC-6	Aluminum rail
BB-2	Float	BC-9	Front leg
BB-4	Cross arm	BC-11	Rear leg
BB-11	Sensitivity weight	BC-13	Level
BB-12	Small balance weight	BC-15	Leveling nut
BB-13	Large balance weight	BC-16	Wing nut
BB-13	Scale	BP-1	Plate
BS-1	Suspension spring	BP-2	Pin guides
BS-4	Support	BP-3	Locking pin



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Secretary of the Treasury

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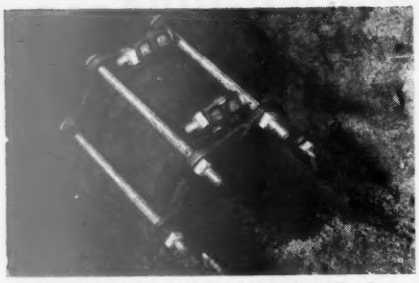

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must be purged of gas and filled with dry air for the next test anyway. When test is complete, close all valves on the balance, also close both cocks on air dryer to prevent moistening of calcium chloride. Be sure that the instrument is locked.

Calculations. When a pocket barometer is used in the field, it should be checked periodically with a mercury barometer. The barometer should be handled very carefully and be well packed for transportation. If barometer reading is in inches and fractions, multiply reading by 25.4 to convert to millimeters. Add barometric pressure in millimeters to both air and gas pressure readings. (If air or gas reading is on vacuum, subtract it from barometric pressure). Divide the absolute pressure for air by the absolute pressure for gas to obtain the specific gravity of gas.

Sample Calculations.

(1) Barometer reading: 753 mm.	Manometer reading	Barometer reading	Absolute pressure
(2) Air reading.....	—127	753 =	626
(3) Gas reading.....	205	753 =	958
(4) Air check reading....	—127		

$$\text{Specific gravity} = \frac{\text{absolute air pressure}}{\text{absolute gas pressure}} = \frac{626}{958} = .653$$

When there is a difference between the temperature for the "air reading" and the temperature for the "gas reading," these temperature readings should be used in calculations as shown by the following example:

1) Barometer reading: 745 mm.	Man. read.	Absol. pres. P	Temp. F	Absol. temp. T
(2) Air reading.....	—95	650	66	526
(3) Gas reading.....	197	942	68	528
(4) Air check reading..	—89	656	70	530

$$\text{Sp. gr.} = \frac{Pa}{Pg} \times \frac{Tg}{Ta} = \frac{650 \times 528}{942 \times 526} = .693$$

Application. The Ac-Me gravity balance is sturdily constructed so that it can be used with equal accuracy in both the field and laboratory, and may be expected to give results with an accuracy of plus or minus two per cent. The degree of accuracy can be proved by comparison with results obtained by applying the direct weighing method to the same sample of gas.

Displacement Balance Method

Apparatus. The apparatus consists of an Arcco-Anubis Recording Gas Gravitometer (it is not intended to imply that there are not other equally accurate and satisfactory instruments utilizing the same principal available) having a balance beam with arms of equal length, at the ends of which are suspended two bells in a sealing liquid contained in two interconnecting tanks. One bell (the balance bell) is open to the air through holes in its crown, the other (the working bell) through a "gas column," a vertical tube connected to the space under the bell. The mechanism of the balance is mounted on the column and is protected by a metal case with a glass window in the door.

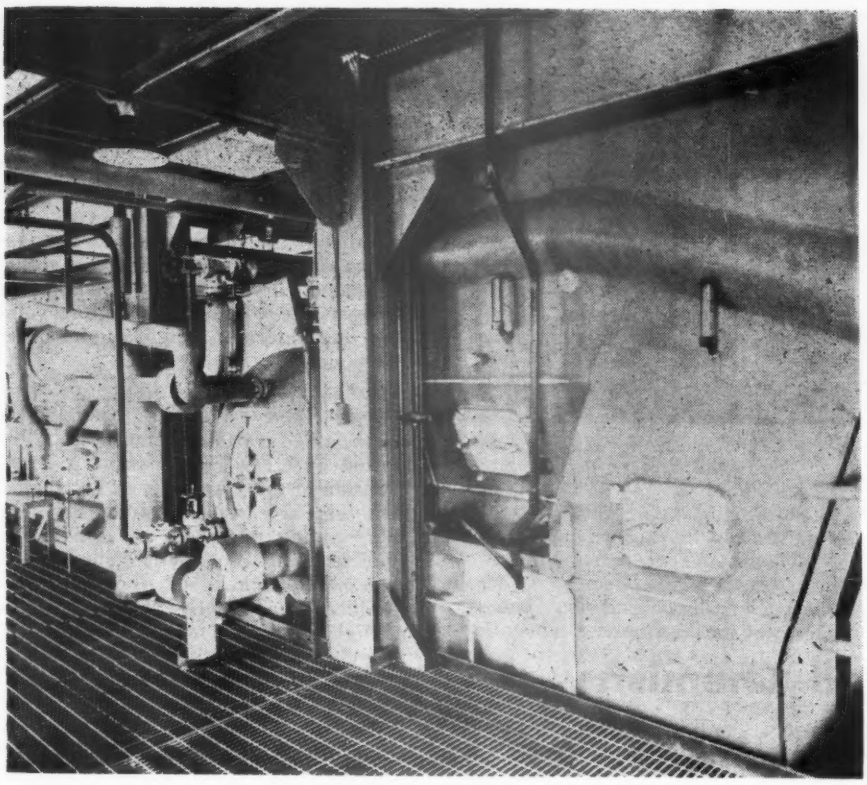
The working force operating the instrument is the difference in pressure on the top and on the underside of the crown of the working bell. This force is equal to the difference in weight between a column of gas and a column of the surrounding (reference) air of the same dimensions. It is opposed by a pendulum weight mounted on a horizontal arm and by a difference in buoyant forces equal to the differences in weight of the sealing liquid displaced by the submerged metal of the two bells. Motion of the beam is transmitted by a connecting rod to a pen mechanism, and the specific gravity is recorded on a clock driven circular chart. The lower ½ meter of the gas column is contained within the case, the upper section of which is removable and attached at the top of the lower section, which projects through the top of the case. At the top of the gas column is a movable cap by means of which the height of the column may be adjusted to compensate for changes in barometric pressure, or set to the height for the average pressure at the location of the apparatus. A scale attached to the cap is marked to correspond to different barometric pressures, and the adjustment for each pressure is made by setting the corresponding scale reading opposite a "barometric index" adjustably attached to the column. Sensitivity of the apparatus and its corresponding "calibration" depend on the correct setting of the barometric index in relation to the combined effects of the pendulum weight and the buoyancy of the sealing liquid.

Gas samples are admitted to the working bell through an orifice at constant pressure. Flow into the apparatus as a whole is controlled approximately by the manual adjustment of a valve, and excess pressure is reduced through a tube dipping into a liquid seal and vented to the outside of the balance case. Within the bell, the sample is distributed through a T-tube and passes out through the gas column at the rate of about 0.7 cu ft per hour. The bell that is open to the air serves to balance the weight of the working bell and to compensate for surface tension of the sealing liquid on the working bell.

Application. This instrument is sturdily constructed so that it can be used with equal accuracy in both the field and laboratory and may be expected to give results comparable to the Acme balance. *F. H. Dotterweich.*

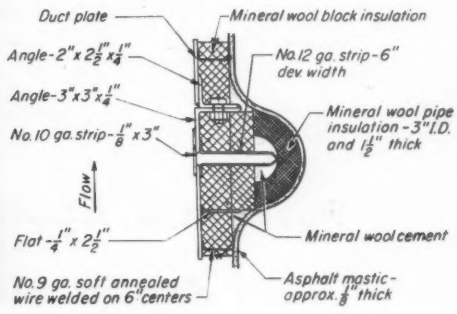
New Lube Testing Device

A method for determining the effectiveness of ultra-thin films of lubricants at pressures previously impossible to measure has been developed by an oil company. The instrument can exert measurable pressures up to 250,000 pounds per square inch between two metal bearing surfaces. This development from competitive oil company research will result in even better lubricants and better products for the American people.



View of insulation of an air duct, showing the pipe-and-block joint insulating technique on a 660 F air line to burners.

Cross section showing materials and construction of expansion around the duct.



Expansion Joint Insulating Technique

New expansion joint technique minimizes surface cracks, hot spots, eliminates special fabrication

MICHAEL K. BONNER

An unusual application of mineral wool pipe insulation has been developed by engineers of the Riley Stoker Corporation to insulate expansion joints on gas and air ducts. Eliminating the cost of special fabrication of the duct plate, the insulating technique is designed for efficient, long-lasting service by minimizing the possibility of such maintenance headaches as surface cracks and hot spots that can be costly in both wasted fuel and excessive repair time.

The drawing shows construction of the expansion joints around the entire perimeter of the duct. The actual gap in the duct plate, approximately 4 in. wide, is covered by two iron angles, welded as shown to one side of the duct plate. As the duct expands and contracts with changes in temperature, sliding occurs between the top edge of the 10-gage strip and the 3 by 3 by ¼-in. angle.

A gas-tight expansion joint is insured by continuous seal welding circumferentially around the entire duct at all points of attachment. The ½-in. bolts secure the two angles together at 24-in. intervals except near the corners of the duct where spacing is reduced to 3-in. The heart of the expansion joint is two 6-in. strips of 12-gage sheet metal, which are formed and welded together at one end and, at the other end, to the respective edges of angle and duct at the expansion opening.

After all the metal work at the joint has been completed, two sections of mineral wool block insulation are cut out to fit directly under the pipe insulation between the 3 by 3 by ¼-in. angle and the ¼ by 2½-in. flat. The thickness of the block insulation, both at the expansion joint and over the rest of the duct, depends on temperature of the air or gas and for most applications does not exceed 3 in. Molded-type mineral wool pipe insulation, 3-in. I.D. and 1½ in. thick, is filled with insulating cement and installed as shown in 3-ft lengths around the duct.

The pipe insulation is secured in place by 1-in. galvanized wire mesh stretched over the insulation surface and wire-laced to 9-gage soft annealed wires welded to the duct plate on 6-in. centers. Adjacent block insulation is also secured by the welded wires, 14-gage lacing wire netting and 1-in. wire mesh. The insulation is finished with a ⅜-in.-thick layer of mineral wool insulating cement and a ⅛-in. coat of asphalt mastic. The mastic may be sprayed with aluminum paint or, for indoor service, any casein paint.

In the accompanying photo, a representative installation in which the pipe-and-block expansion joint insulating technique was used is the insulation of a secondary air duct at the Otter Tail Power Company, Crookston, Minnesota. The expansion joint can be seen on the right following the contours of the large duct supplying 660 F air to the burners of a 75,000 lb per hour Riley steam generating unit. * * *

E. J. Reeves
Magnolia Petroleum Company

M. A. Vela
University of Texas

R. W. Fritzsche
Fisher and Porter Company

Pure and Applied Chemistry at Austin Meet of ACS

In a far-reaching meeting involving about a thousand registrants, Southwestern chemists on December 6-8 discussed all types of subjects at the University of Texas (American Chemical Society) regional meeting, ranging from the most difficult pure chemical researches to methods for metering variable or pulsating flow of fluids in manufacturing operations. Dedication of the new and huge Experimental Science Building at the University, and the presentation of the 1951 Southwest Award for Meritorious Service to Dr. K. S. Markley of the Southern Regional Research Laboratory, U. S. Department of Agriculture at New Orleans are some of the highlights of the assembly.

As is expected, the petroleum and hydrocarbon chemistry portion of the meeting was large and well-attended. Oxidation and catalytic treatment of hydrocarbons, synthesis of new from old hydrocarbons, studies of commercial products, and treatment of plant streams to make specific products are some subjects featured in several papers.

The low-temperature freezing specification for jet (aviation) fuels, now set at minus 76 F is a definitely limiting requirement and affects strongly the amount of kerosine-fraction hydrocarbon product that may be included in these fuels, H. J. Hepp, E. O. Box, Jr., and G. C. Ray of Phillips Petroleum Company's research department. Treatment of kerosine fractions with urea has shown that this reagent is very effective in reducing pour points, which results in lower treating losses than by simple distillation, thus increasing the total amount of kerosine available for blending in jet fuels. Below is a mathematical equation that enables the operator to predict the freezing point of a jet fuel blend from the kerosine freezing point, and also permits calculation of the maximum amount of a given kerosine that can be included in such a fuel (JP-3) to meet the freezing point specification:

$$J = 7.5\sqrt{V} + (F - 75),$$

where

J = Freezing point of jet fuel (F)
V = Volume per cent of kerosine in the blend,
and F = Freezing point of the kerosine (F)

The electron microscope has revolutionized research in numerous ways but nowhere more usefully than in the study of the structure of lubricating greases. M. A. Vela and Dr. W. A. Cunningham of the University of Texas report that lime soap fibers in greases show that these fibers are formed by shearing off ribbon-like sections from larger crystallites, which appear to expand or lengthen and curl during the process. Density patterns indicate a twisting of these ribbon-type fibers, two or more joining together in a braided or rope-like fashion. Further, it seems likely from evidence that fibers also may adhere together, and form "membrane-like sponges or pockets" that are filled with oil.

Many researchers have suspected a contraction of total volume when two or more components of differing molecular weights are blended. Huge quantities of materials are blended in this manner in every refinery every day, and volume losses may be considerable, says E. J. Reeves of Magnolia Petroleum Corporation. Meticulously careful blending of ethane, propane, butane, etc., with naphthas, such blends as might be made in refineries and by other operators on hydrocarbons, show that large volume changes can occur when wide differences in molecular weights are the case. At 100 F the addition of butane to naphtha or gasoline shows 1.6 per cent loss, based on the butane used. Propane shows a 7.0 per cent loss. The author presented curves showing relationships between the volumetric blending value and the molecular weight of the heavy component.

Treatment of hydrocarbons with chromyl chloride, CrO_2Cl_2 results in the synthesis of various ketones, it is reported by C. C. Hobbs and Dr. Bruce Houston of the University of Oklahoma. Reacting in carbon tetrachloride solution, adding one mole of isoparaffins, such as 2- or 3-methylpentane, to two moles of the reagent, the hydrolysis products are chiefly mixed ketones, methyl isobutyl ketone, and ethyl isopropyl ketone, resulting from 2-methylpentane. 3-methylpentane yields methyl sec-butyl ketone and a chlorinated six-carbon ketone, not yet identified; an analogous set of reactions occur when treating 2-methyl butane.

A distinctive dilution technique has been applied to the adsorption analysis of diesel fuels, cracked and straightrun gas oils, Fischer-Tropsch diesel fuels, and the separation of mono and bicyclic aromatics, Ralph L. Hopkins of the U. S. Bureau of Mines reported. For example a sample is diluted with 5 to 20 volumes of a solvent "having an adsorptive affinity similar to, or slightly less than, that of the least strongly adsorbed component of the mixture prior to percolation through the adsorbent". The system is being employed, also, for the removal of sulfur compounds from crude oil distillates under API Research Project 48A.

In testing the cracking efficiency of a catalyst, a sample is withdrawn from the cracking unit (or from storage, presumably) and is tested under standardized conditions, using an "oil heater of unique design that minimizes thermal cracking", and a conical reactor to insure proper fluidization. Operating conditions simulate plant conditions as far as possible. The activity is reported in terms of a standard catalyst sample; selectivity in terms of both a carbon factor and a hydrogen factor, say Paul H. Johnson and C. P. Stark, Phillips Petroleum Company.

Additional papers were given, of wide industry interest, such as the use of rotameter equipment for metering streams beyond the limits of orifice meter practices, by R. W. Fritsche of Fisher and Porter Company. Cyclohexane oxidized with air in the gas phase without catalyst showed a 21.4 mol per cent conversion to formaldehyde at 361 G and 3:1 air-hydrocarbon ratio. Homogeneous catalysts change these results not at all, it appears, while heterogeneous catalysts oxidize all the charge to CO_2 and water. W. F. Hoot and Dr. K. A. Kobe of the University of Texas reported. * * *

AICHE Meeting

Broad Advances in Petroleum Technology

Research and experimentation enlarge chemical horizons in 1951, as revealed by some of those who guided the progress

SPEAKING before 1500 members of the American Institute of Chemical Engineers assembled in Atlantic City recently for their 44th annual meeting, W. C. Edmister and D. H. Buchanan of Carnegie Institute of Technology, Pittsburgh, explained two new applications of the recently proposed integral method of making equilibrium flash vaporization calculations for petroleum fractions.

The authors explained that continuous distillation of petroleum, as conventionally practiced in refining, is essentially a multi-stage separation operation on a continuous mixture of an indefinite number of components, segregating products that are also continuous mixtures. The degree of separation is graphically represented by analytical batch distillation assays, preferably the "true boiling point" curves, for the feed and products.

Man-Made Cyclones

Dr. Donald Dahlstrom of Northwestern University and Dr. Joseph L. Moder, Jr., Georgia Institute of Technology, discussed the separation of ultra-fine solid particles using man-made cyclones, not the natural kind. This device, they stated, separates particles of the same size effectively.

The solid particles are suspended in a liquid and fed to the cyclone, which is a closed container. Tremendous centrifugal forces about 2000 times the force of gravity are developed in the whirling liquid inside the cyclone, it was reported.

The device has been successfully applied to the separation of various types of agricultural products used in manufacture of foods and drugs, they told the AICHE members.

Gas Dehydration

J. M. Campbell, of Black, Sivalls and Bryson, Inc., Oklahoma City, speaking on the tremendous strides that have been made during the last few years in the development of new equipment and the modification of old equipment for the dehydration of gases, stated that many of these new developments have been applied to the drying of natural gas since this industry has expanded tremendously in the post-war period; the growing commercial market has thus made it necessary to develop more efficient methods and practices.

Campbell pointed out that the large majority of all gas dehydrated in this country is by one of these four methods:

1. Dry desiccant plants.
2. Glycol absorption plants.
3. Expansion refrigeration or low temperature plants.
4. Glycol injection plants.

He presented data that indicated the relative cost of four dehydration systems. Triethylene glycol absorption dehydrators have been found to be the most economical both from the initial cost and operating standpoints in those applications where they can be applied. Actual field data show that a glycol dehydration unit may be operated for as low as 0.20 cents per million cubic feet, which is considerably lower than any other plant of equivalent size.

Natural Gas Substitutes

Increased domestic and industrial demands for gaseous fuels have spurred interest in substitutes for natural gas. Synthesis of CH_4 from CO and H_2 is considered as one answer. The method is closely allied to the well-known Fischer-Tropsch synthesis.

This was told to the engineers by a group of Blaw-Knox Construction Company engineers. L. W. Alberts, J. S. Bardin, S. W. Beery, H. R. Jones, and E. J. Vidt, said that a preliminary engineering design had been developed in order to study the cost of producing high BTU pipeline gas from coal. The investment in such a plant capable of producing 250 million SCFD has been estimated to be $150,000,000, exclusive of mining and coal preparation. A non-caking type of coal is fed to Lurgi gas generators to be erected with oxygen and superheated steam. The gas produced in this step contains substantial quantities of methane. This gas is carefully desulfurized and CO_2 is removed. The purified gas is then methanized over a nickel catalyst. Removal of CO_2 formed during methanization leaves high BTU gas, dehydrated, and ready for pipe line distribution.

With coal at $4.00 per ton, gas would cost $0.55 per 1000 std cu ft; at $8.00 per ton, the gas would cost about $.80 per 1000 std cu ft.

The rate of vaporization of drops in a gas stream is important to the design of jet engines. Robert I. Ingebo of the National Advisory Committee for Aeronautics, described a method for measuring the rate of vaporization of nitrobenzene, n-octane, benzene, methanol, acetone water, ethanol, butanol, and carbon tetrachloride from the surface of a small cork sphere in a stream of air.

The results, expressed in terms of the heat transfer coefficient h, can be correlated by the following expression:

$$\frac{hd}{k_a} = \frac{k_a}{k_v} \; 0.5\,(2 + 0.303\,(\mathrm{Re.Sc})^{0.6})$$

Where:

h = heat transfer coefficient
k_a = thermal conductivity of air at average film temp.
k_v = thermal conductivity of vapor at average film temp.
Re.Sc = Reynolds number x Schmidt member = $^{dup}/_{b_{gw}}$
d = drop diameter
u = velocity of air
p = density of air
b_{gw} = molecular diffusivity

A new method predicting the wet-bulb temperature, which very closely approximates the drop surface temperature was presented in this paper.

Reducing Waste

"It is not sufficient that wastes be disposed of, but it is very essential to reduce or eliminate the wastes," E. C. Pattee, consulting engineer, told the chemical engineers. In answering the question, "What are wastes?" the author pointed out that the chemical engineer looks upon them as a mixture of chemical compounds — a source of increased yields or of new products— materials to be disposed of at the least possible cost. The magnitude of the brine disposal problem was indicated on a recent survey made of the Muskingum River, Ohio where the polluting offenders were mainly salt and soda ash plants. In some cases, notably in the oil fields, brines have been pumped into underground structures, Pattee said.

Fin-Tube Exchangers

F. W. Braun, Jr., and James G. Knudsen described experiments aimed at determining power loss in pumping through fin-tube exchangers. Test units were made by assembling circular aluminum fins and copper spacers on solid rods, forming annuli in which pressure drops for water flowing through them were determined. With various combinations of fin height and fin spacing 22 different fin tubes were tested. The data were correlated as friction factor vs Reynolds numbers.

Spray Nozzles

Drop size distributions from spray nozzles was the topic of a paper presented by G. M. Turner and R. W. Moulton of the University of Washington, in which the authors explained that

the performance of spray nozzles is of considerable technical interest because of varied industrial applications. A field presently very active is spray drying. In spite of the sometimes high value of materials handled and the high cost of some types of spray equipment, exact design procedures are not, in general, available, they reported.

Liquid Film Flow

O. B. Bergelin and A. E. Dukler, University of Delaware, discussed the characteristics of flow in falling liquid films. They developed new equations using the von Karman velocity distribution theory, which relates liquid film thickness in concurrent, gas-liquid flow to the flow rates, physical properties of the fluids and to the energy loss. For the case of no gas flowing these equations reduced to give the film thickness as a function of flow rate and physical properties over the complete viscous to turbulent flow range. From these equations it was shown that the transition from laminar to turbulent film flow occurred at a Reynolds number of 1080.

The authors described equipment for the measurement of liquid film thickness and wave profile based on a capacitance technique and this equipment was shown to be capable of measuring film thicknesses to an accuracy of 0.001 in.

Measurements of the thickness of water films flowing down a vertical plate by this technique substantiated the theoretical equations developed for this case to within 0.001 in. The experimental data also demonstrated that the transition Reynolds number was approximately 1000, thus verifying the theoretical prediction.

Separations of Chemicals

A powdered solid—silica gel—can be used to separate organic chemicals, announced James I. Harper, John Lee Olsen, and Frank R. Shuman, Jr., of the Sun Oil Company. Benzene and toluene, both vital to the defense effort, are purified by this the "Arosorb" process.

Describing the mechanics of separation from hydrocarbon mixtures in a static bed of silica gel, during the period when this charge is fed to the bed, aromatics are adsorbed. Following this a low boiling saturated hydrocarbon, say butane or pentane, is used as a "push" liquid to displace the unadsorbed material from the column. Then a higher-boiling aromatic is used to desorb the benzene from the gel, this higher-boiling aromatic being itself adsorbed on the gel. In the next cycle the charge aromatics are adsorbed, replacing aromatic desorbent on the gel. The effluent from the bed consists of a portion high in aromatics, a portion low in aromatics, and an intermediate portion, which is recycled to charge.

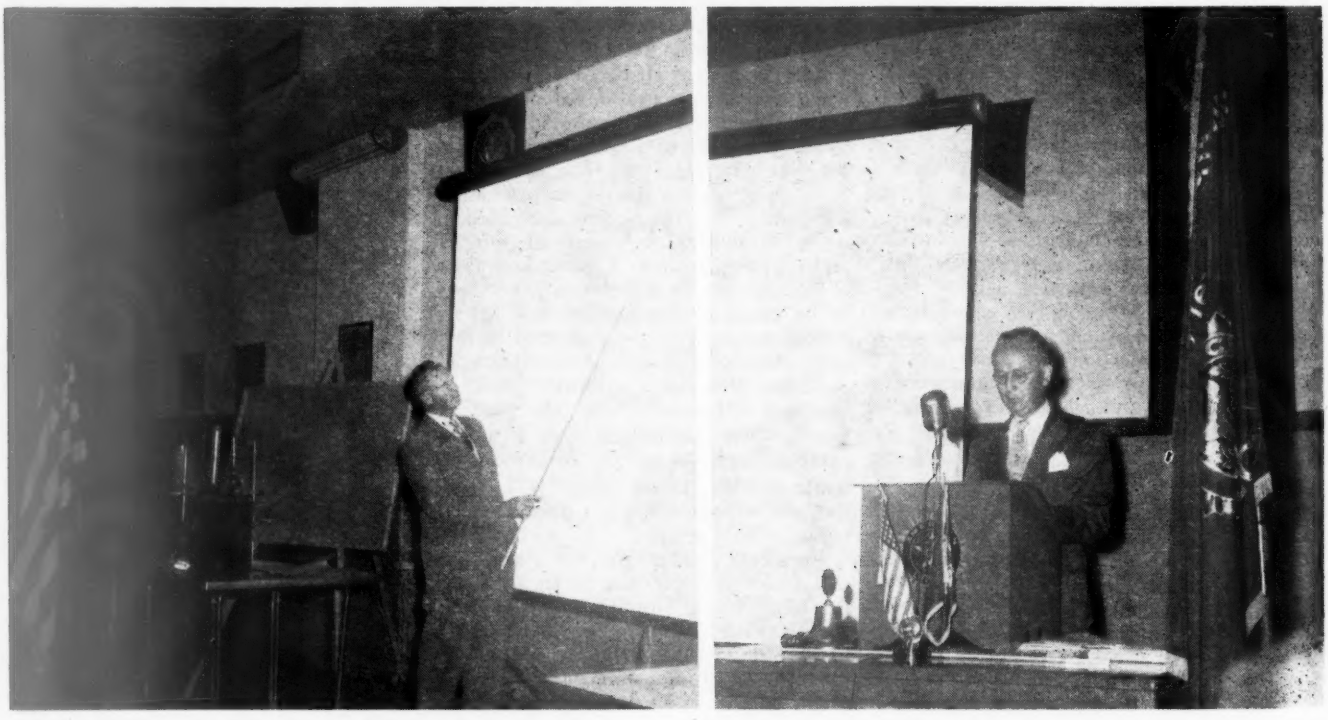
Silica gel of mesh size 28-200 is employed. Its efficiency and life are protected by pretreating the feed in driers that lower the water content of the feed to 20 ppm and remove trace quantities of poisons such as nitrogen, sulfur, and oxygen compounds.

In a commercial plant, a multiple number of beds would be used, staggered in time. The flows to all beds would be controlled by a cycle timer, and the actual rate in each bed would be maintained constant by a flow controller on the effluent from each bed. The effluent composition is followed by a device that measures the dielectric constants of the effluent, automatically cutting it to aromatic, saturate, and recycle manifolds.

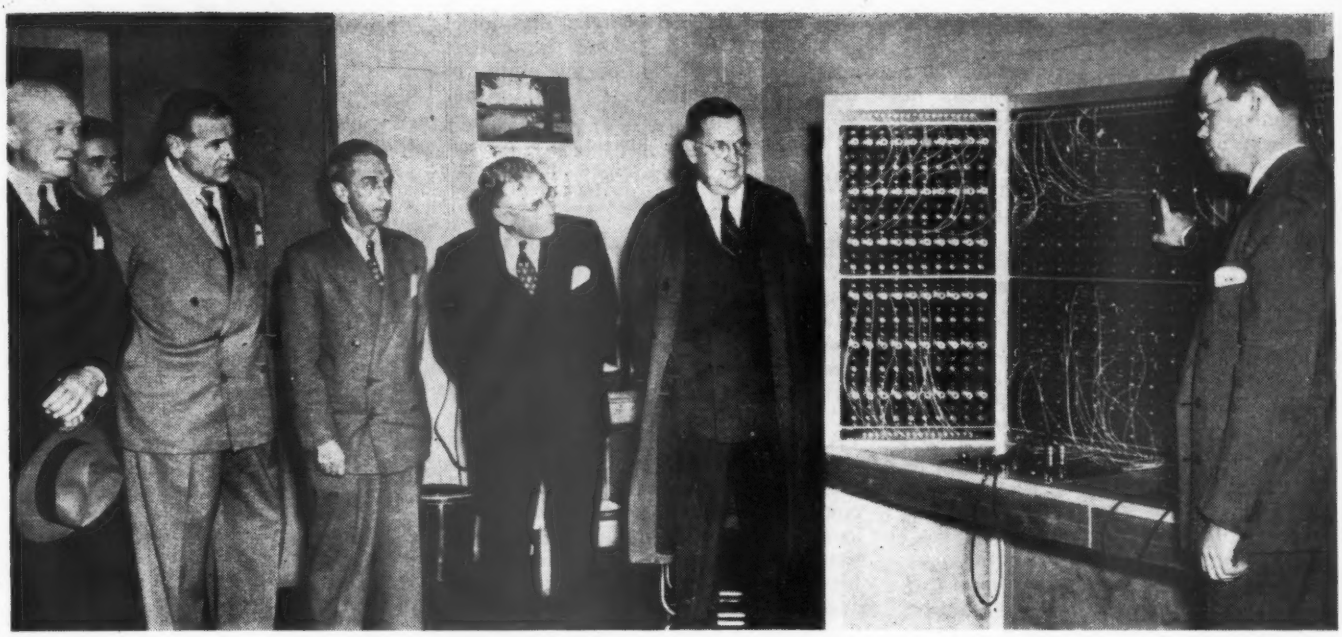
Ethylene Oxide

C. J. Walters and J. M. Smith of Purdue University described the investigation they carried out to develop an apparatus suitable for measuring the pressure—volume—temperature relations of oxygenated organic compounds. Ethylene oxide was chosen for the initial study largely because of its importance in the chemical industry.

The authors measured the volume of ethylene oxide in vapor and in saturated liquid regions in a compressibility bomb from 14.7 to 600 lb/sq in. abs over a temperature range of 70 to 310 F. Additional data were taken in the critical region ($t_c = 384.4$ F, $P_c = 1043$ lb/sq per in. abs, $V_c = 0.051$ cu ft/lb). Polymerization at temperatures above 220 F was rapid enough to require measurements as a function of time. At 310 F the volume decrease was 0.4 per cent per hour. * * *



Two Speakers at NGAA Meeting. Charles Holmes, Stanolind Oil and Gas Company, reviewed old testing methods and told of new ones at a recent meeting of the Southern Regional Division of the Natural Gasoline Association of America. Holmes surveyed early efforts to develop methods for finding out the gasoline content of gas, and presented in detail the operation, shortcomings, and peculiarities of the charcoal and compression detail methods. He added that he believed ethylene glycol is as good as glycerine in testing, and is much more economical. Harold Legatski, Phillips Petroleum Company, spoke to the meeting on planning for greater economy of operation. He recommended a planned operation run by the operators instead of one that runs the operators. He suggested weekly, monthly, semi-annual, and annual checks on new units in order to get low cost and high efficiency operation.



The Institute of Gas Technology distribution system calculator, constructed with funds contributed by Mr. and Mrs. F. H. Lerch, Jr., is demonstrated by B. E. Hunt to (from left) James Comerford, executive vice president of Consolidated; Director E. S. Pettyjohn, John Clark, president of Hope; Will Rogers, president of East Ohio; and Chairman Lerch.

Ten Years Progress by Institute of Gas Technology

THE Institute of Gas Technology, affiliated with Illinois Institute of Technology in Chicago, has in the short space of 10 years grown from a vision to an established educational and research institution, and is embarked upon its second decade of operation with a program of steadily increasing service to the gas industry.

The Institute had been founded by leaders of the gas industry to fill the industry's pressing need for its own educational and research facility. Few utility companies are able to hire a man upon his graduation from a college or university, and immediately put him to work in any phase of their operations. Instead, they must ignore a portion of his education which they cannot use, and begin on a course of acquainting and training him to their particular needs.

Prodded by Frank C. Smith, president of the Houston Natural Gas Corporation, the executive board of the American Gas Association in 1939 appointed a committee to study the possibility of special training in schools. The committee, which was headed by Smith, turned in a report suggesting a combined educational and research institute. The executive board of the American Gas Association agreed that such a project should be developed. Frank H. Lerch, Jr., (then president of Gas Companies, Inc., and now chairman of the board of Consolidated Natural Gas Company), was made chairman of a Committee on Affiliation of the proposed institute with an outstanding engineering school. Herman Russell (then president, now chairman of the board, of Rochester Gas and Electrical Company), was appointed chairman of a Committee on Financial Support.

By June of 1941 the two committees had obtained their goals. Financial support was not great; only 12 companies had signed pledges to become associate members, and about as many additional promised to sign. Their combined dues would amount to about $45,000 per year, but in 1941 that was sufficient to start the school. Affiliation was arranged with Illinois Institute of Technology, and the Institute of Gas Technology was formally incorporated, not for profit, under the laws of Illinois.

In their first announcement of the new Institute, the sponsors gave it these objectives: 1) training of men specifically for the gas industry; 2) prosecution of fundamental and applied research for the gas industry; 3) collection and dissemination of scientific information for the gas industry; 4) coordination of research within the gas industry.

Classes were under way before the end of September, 1941, with four selected graduate students. Instructors outnumbered them 2-to-1, and busied themselves in securing equipment and having it installed. The next year there were 15 Fellows, and in 1943 a total of 22. Then World War II and Selective Service took all but two of the Fellows, and operation of the school was practically suspended. Only four students had completed the requirements and received the degree of Master of Science; one was able to continue to the Doctorate.

Records show that the research activities of the Institute were not extensive during the first few years; emphasis was placed on education alone. Now the wisdom of the sponsors in including research as a complementary objective kept the Institute from closing its doors. The staff was occupied with research, but limitations of manpower and equipment were severe.

The rise of the Institute to its present position in fulfilling all of its objectives did not begin until the end of World War II. Since 1946 it has grown at a rapidly accelerating rate, reaching a climax in less than 5 years in the construction and equipping of a new building, and acquisition of a pilot plant at Crawford Station of The Peoples Gas Light and Coke Company. The Institute today has a plant investment in excess of $1,000,000, and its operation is economically sound, within income.

Highlights of the Institute's first 10 years of operation and its present activities are presented in these excerpts from the 1951 annual report of the director, Capt. E. S. Pettyjohn, who has headed the Institute since World War II.

A Review of 10 Years

"Our 10-year statement shows the total number of dollars that have been made available to the Institute for the basic purposes for which it was created. The first of these purposes is the train-

ing of men for the gas industry. We have expended some $293,000 in our educational program, and have graduated 2 Doctors of Philosophy, 5 Masters of Science, and 27 Masters of Gas Technology, most of whom have been employed in the Industry.

"Our second objective was the carrying forward of basic and applied research, either with our own funds or with funds made available by member companies or by agencies interested in the gas industry. In the last 10 years we have expended $1,058,000 on 33 AGA projects, $504,000 on sponsored projects, and $20,000 in sponsored tests. In addition, we have expended on 20 basic research projects $249,000 which has come from our members' dues and from contributions.

Dissemination of Information

"The problem of disseminating our sponsored research results is a most difficult one. In the past 10 years we have published 48 papers and made 35 presentations, largely to meetings of the AGA.

"We have prepared 503 research reports, 170 of which have been to . . . committees of the AGA. These reports give the progress of the work at intervals when the developments have reached a point where a summation can be made. In addition, we send a monthly work report to every member of the Project Supervising Committee, and to each member of the sponsoring committee and the Technical Advisory Committee.

Research Bulletin Series

"In 1948 we instituted our Research Bulletin Series, publishing the results of 3 studies. In planning, constructing, and moving into the new building, we were unable to keep pace with our developments. This year we have reactivated the Series, and the first two numbers have just come off the press. We have material for 12 additional bulletins . . . and during this current fiscal year we should be able to convey to you the results of our research program more directly."

"Our major research activities have been devoted to the production of base load and peak load gases, beginning with the raw materials: Natural gas, natural gas condensates, petroleum, and coal . . . The work on catalytic cracking of natural gas is paying immediate dividends. There are 6 tube-type plants and about 17 cyclic catalytic reforming units in operation. The same is true of our work on petroleum, especially the selection of oils for high-Btu oil gas. There are some 18 plants in New England which have been or are being converted to high-Btu oil gas as a supplement for natural gas.

"The basic raw material of the future is coal . . . These coal projects are long-range studies looking toward improvements in existing processes to meet future requirements when natural gas and oil supplies will be inadequate . . . Meeting peak loads for natural gas systems is our most pressing problem.

"Analytical research carried on as part of the Basic Research Program . . . is necessary as all of our work and our results are predicated on our ability to measure either the raw materials that go into our processes, or the products at intermediate or final stages . . . it provides the background information essential for process development.

Need for Associate Memberships

"The cost of carrying forward the major objectives of the Institute—the educational program, the information service, including gas abstracts, and the basic research program — is borne largely by associate members' dues.

"The Institute was created before the PAR Plan and originally had no competition within the gas industry in the solicitation of support from individual companies. Now, the PAR Plan stands as a partial barrier against this solicitation, because few persons distinguish between our Associate Members' dues and the PAR subscription. A contribution to the promotion, advertising, and research program is not a contribution to the Institute, but provides funds for research projects.

"This research is extremely important in providing facilities and has accounted for much of the equipment which we have at present, but it does not provide the firm income which is necessary to assure the building of a staff skilled in the solution of gas industry problems and to assure continuation of the educational and basic research programs. This assurance can only come from our associate members' dues."

Standard-Vacuum to Build New Delhi, India Refinery

Standard-Vacuum Oil Company confirms press dispatches from New Delhi on its agreement with the Government of India for the construction of an oil refinery in the Bombay area, which will manufacture petroleum fuel products for the use of the Indian public.

The $35,000,000 refinery will be built and managed by Standard-Vacuum through a subsidiary company to be incorporated in India. Indian investors are being invited to participate up to 25 per cent of the capitalization on a preferred stock basis.

In agreeing to the project the Government has guaranteed protection for 25 years against expropriation of the properties. The company has assured the Government that it will complete the refinery as soon as possible and will undertake to train Indian personnel in technical operations. Standard-Vacuum a major petroleum marketer in India since the 1890's, now employs more than 5000 people in its marketing organization in India, of whom 99 per cent are Indians.

The refinery will have a processing capacity of approximately 19,000 bbl per day and probably will be operated on crude from Persian Gulf sources. It will be several months before process designs are completed. The company expects to place the refinery in operation not later than 1956.

New Multi-Million Dollar Phenol Plant for Canada

The Canadian Kellogg Company, Ltd., a subsidiary of The M. W. Kellogg Company, refinery and chemical engineering-contracting firm of New York City, has been awarded a multi-million dollar contract for a unique phenol plant at Montreal for B. A.-Shawinigan Limited, a new company jointly owned by the British American Oil Company and Shawinigan Chemicals Limited.

According to Kellogg, the new plant, which will produce 13,000,000 lb of phenol annually, will be the first commercial unit of its type. It employs a process under license from the Hercules Powder Company of Wilmington, Delaware, and Distillers Limited, London, by which cumene, a petroleum derivative, is oxidized to produce both phenol and acetone. Cumene will be piped from the Montreal refinery of British American Oil Company.

Both phenol and acetone, upon completion of the unit, will be available for sale to Canadian industry and for export. Both are used in the manufacture of plastics and many other commercial products.

Pan-Am Sets Up Plan For Polybutene Units

Pan-Am Southern Corporation will enter the petro-chemical field shortly with the addition of two important manufacturing units at the El Dorado, Arkansas, refinery.

R. T. Colquette, Pan-Am's vice president in charge of manufacturing, said the units will turn out polybutene needed for manufacture of motor oil additives and other products, and propylene tetramer used to manufacture synthetic detergents. The polybutene unit is to be completed by February 1, 1952.

The unit to be operated at El Dorado will be able to produce more "polybutene" than is currently sold in the entire nation—2,000,000 gal per year. This will be used to meet future increased national demands for military and important civilian uses. In addition to its use in lubricating oil additives, "polybutenes" are used in calking and sealing compounds, electrical condensers and capacitors, aluminum roll oil, surgical tape and pressure sensitive industrial tapes, laminated paper, tracing paper, and surface coating materials.

The propylene tetramer unit is being constructed by revamping the present polymerization unit at El Dorado. This unit will be reworked in such a way that high grade "poly" gasoline can also be made whenever desired, depending on fluctuation in market demands for tetramer.

Annual production of tetramer by the unit will be approximately 3,800,000 gal a year after its completion. The entire output of the tetramer unit will ultimately be consumed in making "alkymer," one of the three principal base stocks for production of synthetic detergents.

NEWS

West Texas Gasoline Plant Will Serve Pegasus Field

Magnolia Petroleum Company has entered into an agreement for the construction of a gasoline plant to serve the Pegasus field of Midland and Upton counties in West Texas. The contract for building the compressor station, process and storage facilities has been awarded to the Hudson Engineering Corporation of Houston.

The initial capacity of the plant is designed for the handling of 30,000,000 cu ft of casinghead gas per day. Construction will begin next month.

The total liquid products that will be natural gasoline, butane, and propane, will amount to over 100,000 gal per day. The plant is being designed so that it can be expanded easily as the Pegasus field is further developed. The limits of Pegasus, a major field in the vast Permian Basin of West Texas, have not yet been fully defined. It was discovered in 1949 by Magnolia, an affiliated organization of Socony-Vacuum Oil Company, Inc.

Shell to Boost Capacity Of Refinery by 50 Per Cent

A $30,000,000 modernization and expansion of the Shell Oil Company refinery at Norco, Louisiana, largest program in the plant's history, was announced by P. E. Hurley, manager. Daily capacity of the refinery will be boosted approximately 50 per cent, from 2,100,000 gal to 3,150,000 gal.

Expansion of the Norco refinery is part of a $100,000,000 program that will add 4,000,000 gal a day to Shell's output nationwide. "Mobilization is taking tremendous quantities of oil and the growing civilian economy is requiring still more", Hurley said. "The company is trying to keep up with demand".

The most important unit to be installed at Norco is a large modern catalytic cracking plant. Among other advantages, this move will make the refinery independent of the Shell plant at Houston, Texas, in the production of high octane aviation fuels. At present Norco brings high octane base stock from Houston for blending here.

Crude oil distillation capacity will also be increased and the alkylation plant will be greatly expanded. Alkylates are an important ingredient of high octane fuels. Expansion of Norco's production facilities will also necessitate additional storage tanks, more cooling water equipment, more utilities, and other facilities.

The Norco refinery, a veteran among petroleum plants in this area, has been steadily improved during the past 25 years, from an original daily output of some 630,000 gal of products to its present 2,100,000 gal. This spectacular increase has been accomplished in most cases by boosting the operation of existing equipment far over designed capacities, and by constantly increasing efficiency through improved technology.

General Petroleum Raises Aviation Fuel Output

A refinery improvement project designed to increase production of critically-needed aviation fuel components has been launched by the General Petroleum Corporation at its Torrance, California, refinery. The project will cost over $500,000.

A key part of the new facilities is a giant distillation tower, 10 ft in diameter and 157 ft high. The tower was originally built during World War II as a segment of a complete aviation gasoline refining plant which was to be shipped to Soviet Russia under Lend Lease. The shipment was cancelled in 1945.

General Petroleum engineers, faced with current steel shortages, located the tower and, through design adaptations, made possible its use in the new Torrance project. Their ingenuity saved a total of 200 tons of scarce steel. Contract for the erection of the new facilities has been awarded to J. B. Gill Company. Completion is scheduled for June, 1952.

Belgium Refinery Set Up

Antwerp, Belgium's first major refinery is increasing its production from 28,000 bbl a day to 40,000 to meet urgent needs of expanding market requirements in the Benelux countries and Switzerland. Owned by the Society Industrielle Belge des Petroles S. A., the refinery is a joint venture of Anglo-Iranian Oil Company and Petrofina, the Belgium oil company. Official opening ceremony is expected to be held early this spring.

Continental to Install UOP Platforming Unit

Work will begin shortly on the installation of a UOP Platforming unit at Continental Oil Company's Lake Charles, Louisiana, refinery. Announcement of the agreement was made from Continental's offices at Ponca City, Oklahoma, by H. G. Osborn, vice president in charge of manufacturing.

The unit will have a daily charge capacity of 5000 bbl for aromatics production or 6000 bbl daily for motor fuel.

Continental will process a charge stock of approximately 150-220 deg boiling range Coastal straight run gasoline in its benzene and toluene manufacture and a 250-400 deg cut for motor fuel production.

Design of the Continental Platforming unit will be by Universal Oil Products Company, Chicago, discoverers and developers of the UOP Platforming process. Construction will be handled by Procon Incorporated, Chicago.

Alamo Chemical Plans Set

Plans have been completed for the formation of Alamo Chemical Company on the Houston Ship Channel by Phillips Chemical Corporation, General Aniline and Film Corporation, and the Borden Company. First operations are expected to begin in 1953, with the entire program to be completed by 1959. Paraldehyde will be purchased and methylethylpyridine synthesized by the same method employed by the Nepera Chemical Company. Gas requirements for the new plant are said to be about 40 to 50,000,000 cu ft per day.

Lloyd I. Hughes
President

John J. Paulin
Executive Vice President

Kaighin and Hughes Move Into New Headquarters

Kaighin and Hughes, Inc., recently moved into its new $200,000 headquarters building in Toledo, Ohio. Born in the depression year of 1933, the firm has made great spectacular growth in its 18-year history. The company features complete integration of experienced engineering, design, procurement, fabrication, and installation departments, in contract to many other engineering firms, Lloyd I. Hughes, president, has stated.

In 1933 the two founders, Hughes and Arnold T. Kaighin, partners, were the two main employees, whereas today there are more than 2000 including 100 engineers. Originally the firm was qualified to do work in Ohio only, but today has spread to 19 states. Although the first year's business amounted to only $18,000, the years since have produced a $100,000,000 volume.

Other officers of the company are John J. Paulin, executive vice president; James A. Austin, secretary-treasurer; George A. Ulmer, vice president and project manager at Oak Ridge; C. E. Barnes, vice president in charge of Akron operations; G. R. Gottschalk, Syracuse, assistant to the president, and Kent R. Kaighin, son of Arnold T. Kaighin, assistant secretary.

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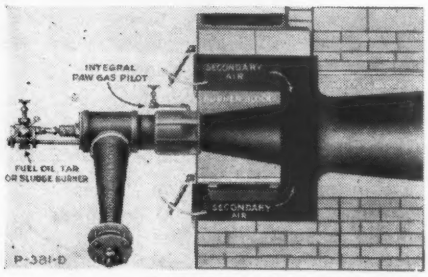

TANDEM COMBUSTION UNIT

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Main Offices & Factory: 1259 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

Two New IGT Bulletins Out

Two new bulletins of the Institute of Gas Technology have been issued recently. These are "Sulfur Poisoning of Nickel Catalysts", (No. 10), by C. H. Riesz, H. A. Dirksen, and W. J. Kirkpatrick, and "Expansion Behavior of Coal During Carbonization" (No. 11) by O. P. Brysch and W. E. Ball.

No. 10 is priced at $2.50, and No. 11 at $5, available from the Institute at Chicago 16, Illinois, in heavy paper binding. Issuance of these bulletins marks the resumption of publication of IGT bulletins, which was suspended in 1948. During the past and including the most recent two issues, the Institute has published six bulletins on various subjects. Thirteen investigations are in preparation to report findings and will be issued in the order in which they are completed, edited, and printed. "Early publication of all (bulletins scheduled) is anticipated", said Institute Director E. S. Pettyjohn.

New Research Firm Set Up

Bode-Lowry and Associates is the name of the new market and sales research organization for the chemical, petroleum, and petrochemical industries organized recently, with headquarters at 80 East Jackson Boulevard, Chicago. Charles D. Lowry, Jr., and Harold E. Bode are the senior partners in the firm, each well known in his field throughout the country and abroad.

Dr. Lowry has been engaged for nearly a quarter-century in technical sales engineering for Universal Oil Products Company, interested primarily in anti-oxidants for the petroleum and food industries. Trained in organic research at Northwestern and Harvard Universities, and at the University of Munich, Germany, Lowry is universally known in his special field. Bode has been active especially in chemical market research and as assistant director of chemical patents for Corn Products Refining Company, is a chemical engineer from Illinois Institute of Technology, and has been in independent market research for six years.

The new company will handle all phases of commercial chemical development, supervise application research between clients and other companies, and will study markets for new products and by-products.

Iraq Refineries Reported

A new refinery with a capacity of 100,000 tons has been announced for Basra, Iraq, by the prime minister, Nouri Pasha El Said. Construction will take about 9 months. This new refinery will serve to supply all southern Iraq, which heretofore had been supplied from Abadan.

The prime minister also reported that another refinery will be installed in northern Iraq, to produce bitumen, also formerly supplied from Abadan. Basrah Petroleum Company is expected to begin within a few months to produce crude oil, and to produce within 2 or 3,000,000 tons in its first year.

—PERSONALS—

Richard H. Wilhelm, professor of chemical engineering at Princeton University received the William H. Walker Award of the American Institute of Chemical Engineers as recognition of his achievements in chemical engineering.

Professor Wilhelm was chosen on the basis of "his excellent publication record over the years and for recent outstanding contributions" to the literature of the chemical engineering field. Professor Wilhelm was chosen by a jury of chemical engineers headed by Dr. Allan P. Colburn, Provost of the University of Delaware.

Charles R. Wilke, associate professor of chemical engineering at the University of California, has been chosen by the American Institute of Chemical Engineers as this year's winner of their Junior Award. The honor is given for outstanding contributions to the literature of chemical engineering. Professor Wilke was especially cited for his work on, "Estimation of Liquid Diffusion Coefficients," "Diffusional Properties of Multicomponent Gases," and "Limiting Flows in Packed Extraction Columns."

Dr. Alan S. Foust, professor of chemical engineering at the University of Michigan, will become head of the Lehigh University's department of chemical engineering. **Dr. Earl J. Serfass,** professor of chemistry here, will become the new head of the department of chemistry. In making the announcement, President M. D. Whitaker said that **Dr. Harvey A. Neville** now will devote full time to his duties as director of the Lehigh University Institute of Research, dean of the graduate school, and professor of chemistry.

Foust was graduated from the University of Texas in 1928, received his master's degree there in 1930, and his doctor of philosophy degree in chemical engineering in 1938 from the University of Michigan. He served as chemist in charge of corrosion studies for the Magnolia Petroleum Company, Beaumont, Texas; and as development engineer of a vapor phase cracking process for the Texas Pacific Coal and Oil Company.

Serfass was graduated from Lehigh in 1933, received his master's degree here in 1935 and Ph.D. in 1938.

H. R. Wall

L. D. Grubb

W. B. Strobel

H. R. Wall, assistant superintendent of Continental Oil Company's Ponca City, Oklahoma, refinery, has been promoted to superintendent. **L. D. Grubb,** director of technical services for Cit-Con Oil Corporation, Lake Charles, Louisiana, had been named assistant superintendent of the Ponca City refinery, succeeding Wall.

Wall succeeds **C. D. Hull,** who has been promoted to the newly created position of manager of the Ponca City refinery. Wall received his B.S. degree in electrical engineering from the University of Colorado and joined Continental in the Denver refinery in 1935. He became superintendent at the company's Lake Charles refinery in 1948 and assistant superintendent of the company's largest refinery, in Ponca City, in 1950.

Grubb, a graduate of Kansas State College, joined Continental as a technologist at Ponca City in 1939. He was transferred to the Cit-Con refinery at Lake Charles in 1947, as director of technical services, from Ponca City.

W. B. Strobel, Ponca City, Oklahoma, senior chemical engineer in the process division of Continental's manufacturing department, has been promoted to the newly created position of technical assistant to Dr. John E. Kircher, Houston, manager of the company's petrochemical department. Strobel will move from Ponca City to Houston, where he will make his headquarters.

Strobel is a graduate of the University of Colorado, where he received his MS degree in chemical engineering. He joined Continental Oil in 1948, and in this year was promoted to senior chemical engineer in the process division.

Dr. W. A. Gruse

Dr. William Arthur Gruse, administrative fellow of the petroleum refining fellowship at Mellon Institute, has been named to receive the Pittsburgh Award for outstanding service to chemistry, the Pittsburgh Section, American Chemical Society, announces.

The award recognizes the important advances made under Dr. Gruse's direction in the chemistry of refining petroleum. The work of his fellowship, sustained by the Gulf Research and Development Company, has resulted in basic improvement in the refining of gasoline, lubricating oil, waxes and, in short, essentially all petroleum products.

J. H. Forrester of Oklahoma City, Oklahoma, has been named manager of research to fill the vacancy created by the appointment of **Dr. R. C. Gunness** to the position of assistant general manager of manufacturing, Standard Oil (Indiana). Forrester is currently manager of the central division of the Stanolind Oil and Gas Company.

Forrester received undergraduate training in chemical engineering at Massachusetts Institute of Technology in 1932. He held various positions in the research department of the Standard Oil Company beginning in 1929, and was associate director of research and director of technical service at the time of his transfer to Stanolind in 1946.

D. R. Johnson, manager of Continental Oil Company's manufacturing department, who has maintained headquarters in Ponca City, Oklahoma, has moved to Houston, as executive headquarters representative of the Company's manufacturing department. He will continue as department manager. It was announced at the same time that **Charles D. Hull,** superintendent of the company's Ponca City refinery, had been promoted to the newly created position of manager of the refinery.

Johnson joined Continental in 1924 in Glenrock, Wyoming, and went to Ponca City in 1929 as inspector and technologist. He has remained there since that time, moving up in the department through various promotions.

Hull joined the company in 1919 and also spent his entire tenure at Ponca City, rising through promotions to assistant to the vice president in 1928. He was promoted to superintendent of the Ponca City refinery in 1949.

▸ **John T. Balhoff** has joined the patent section of the Ethyl Corporation and has been assigned to the company's manufacturing plant at Baton Rouge, Louisiana. Balhoff received his B.S. degree in chemical engineering from the University of Detroit in June of this year.

Prior to joining Ethyl, he was employed by the Arthur M. Smith patent firm in Dearborn, Michigan. In his new assignment as patent agent at Baton Rouge, Balhoff will be responsible for the execution of patent applications dealing with chemical processes developed at the plant.

▸ **William I. Burt,** vice president—manufacturing, of The B. F. Goodrich Chemical Company, Cleveland, Ohio, has been elected president of the American Institute of Chemical Engineers for 1952, at its 44th annual meeting.

At the same time, it was announced that the members had also, through their mail ballot, elected as vice president, **William T. Nichols,** who is director, general engineering department of Monsanto Chemical Company. **Stephen L. Tyler** and **C. R. DeLong,** both of New York City, were re-elected executive secretary and treasurer respectively.

Five new directors were chosen by the chemical engineers. **William T. Dixon,** of Philadelphia, Pennsylvania, was elected for a one-year period. He is manager, design division, engineering and construction department of The Atlantic Refining Company, Philadelphia. Four directors, elected to serve for a three-year term, are **J. Henry Rushton,** professor of chemical engineering and director of department, Illinois Institute of Technology, Chicago Illinois; **Philip H. Groggins,** chief, agricultural chemicals section, chemical division, National Production Authority; **J. C. Elgin,** professor of chemical engineering, chairman of department and associate dean of the engineering school, Princeton University; and **Arthur K. Doolittle,** assistant director of research, Carbide and Carbon Chemicals Company, South Charleston, West Virginia.

The new president, Burt, has been with B. F. Goodrich Chemical since 1927, and was prior to his position as vice president, the superintendent of production of the chemical division, and manager of chemical manufacturing division. Nichols, the new vice president, has been with Monsanto Chemical as director of the general engineering department since 1949. Dixon was educated at Princeton and Massachusetts Institute of Techonolgy. He has been with Atlantic Refining since 1927.

▸ **Dr. Arno C. Fieldner,** chief fuels technologist of the Bureau of Mines, received an honor award from the Washington Society of Engineers recently. Dr. Fieldner, nationally known inventor and developer of many techniques of testing and analyzing coal, coke, and gas, was awarded for his outstanding professional achievement.

A graduate of the Ohio State University, Fieldner has been with the Bureau of Mines for 40 years. He was formerly head of the fuels and explosives branch.

Charles E. Maschal, left, manager, Marcus Hook refinery of Sun Oil Company, was honored in absentia on the 60th anniversary of Drexel Institute of Technology, Philadelphia, recently. He is shown above receiving his alumni citation from Dr. James Creese, president of Drexel Institute, in a private ceremony.

▸ **Ben G. Symon,** manager of the Shell Oil Company lubricants department, has been elected chairman of the lubrication committee of the American Petroleum Institute. The committee, composed of leading lubrication experts from various oil companies, serves both the petroleum industry and users of lubricants.

A prime objective of the API lubrication committee is to study lubrication problems resulting from new and improved design in mechanical equipment. The group also disseminates information about lubricants, with the purpose of prolonging the life of mechanical equipment through the application of sound lubrication engineering principles. Symon is a past president of the National Lubricating Grease Institute, a director of the National Petroleum Association, and has served 23 years with Shell Oil Company.

▸ **Edmond L. d'Ouville** has been appointed division director of research in the Standard Oil Company (Indiana) research department at Whiting, Indiana, where he will be responsible for information and patent activities. He will also continue as senior technologist in the development and patent department in the company's general office at Chicago.

Dr. d'Ouville joined Standard in 1937 as a research chemist at its Whiting laboratories. In 1942 he left Standard to join the staff of the Mellon Institute, Pittsburgh, Pennsylvania, as a research fellow. He returned to Standard in 1944 as senior technologist in the development and patent department.

D'Ouville did undergraduate work at Villanova college and received the Ph.D. from University of Pennsylvania.

▸ **Dr. James H. Gardner** has joined the petrochemical research department at National Research Corporation, Cambridge, Massachusetts. He received his B.S. in chemical engineering from the University of Utah in 1947. In 1950 he received his Ph.D. from Harvard University. Subsequently, Dr. Gardner was employed as a technologist by Shell Oil Company at Deer Park, Texas, and as a lecturer in the chemical engineering department at the University of Houston.

Dr. Gardner will supervise the physical chemistry phases of the petrochemical research program undertaken jointly by National Research Corporation, Electric Bond and Share Company and United Gas directed toward the development of new chemicals from natural gas. He is a member of the American Chemical Society.

▸ **Norman T. Robey** was named assistant general superintendent of the Casper, Wyoming, refinery of Standard Oil Company (Indiana). He was formerly assistant superintendent of the heavy oils division at the company's Wood River, Illinois, refinery. Robey joined Standard in 1936 as a chemical engineer in the Whiting, Indiana, research laboratory, where he became a group leader in 1941. Two years later he was transferred to the Wood River refinery as foreman of the catalytic cracking unit.

He subsequently served at Wood River as general foreman of the cracking department, assistant superintendent of the light oils division, and supervisor of training in the industrial relations division before assuming his present position as assistant superintendent of the heavy oils division. Robey is a graduate of the University of Illinois and Massachusetts Institute of Technology.

Dr. Charles L. Thomas

Dr. Charles L. Thomas has joined the Research and Development staff of Sun Oil Company. Well-known in petroleum circles for his publications and patents, he has spent most of his professional career with the Universal Oil Products Company where he did outstanding work on catalysts and catalytic processes for petroleum refining. For the past six years he has been director of research and development for the Great Lakes Carbon Corporation.

Dr. Thomas has been active in scientific societies, particularly the American Chemical Society, of which he has been vice chairman of the Petroleum Division and chairman of the Chicago Section.

A native of North Carolina, he received both bachelor of science and master of science degrees from the University of North Carolina and a Ph.D. degree from Northwestern University.

G. P. Connell, professor and head of the department of chemical engineering of Lawrence Institute of Technology, has joined the corrosion engineering staff of the Hinchman Corporation, according to J. F. Hirshfeld, the firm's vice president. Connell is a graduate of McGill University, Montreal. He has had extensive construction and manufacturing experience in many phases of the chemical industry from the electrolytic decomposition of salt to the manufacture of explosives and also in the design and erection of chemical process plants involving many corrosion problems.

Donald L. Johnson has joined the patent section of the Ethyl Corporation research laboratories at Detroit, Michigan. Johnson received his B.S. degree in chemical engineering from Purdue University in 1947, and his Juris Doctor degree from George Washington university earlier this year.

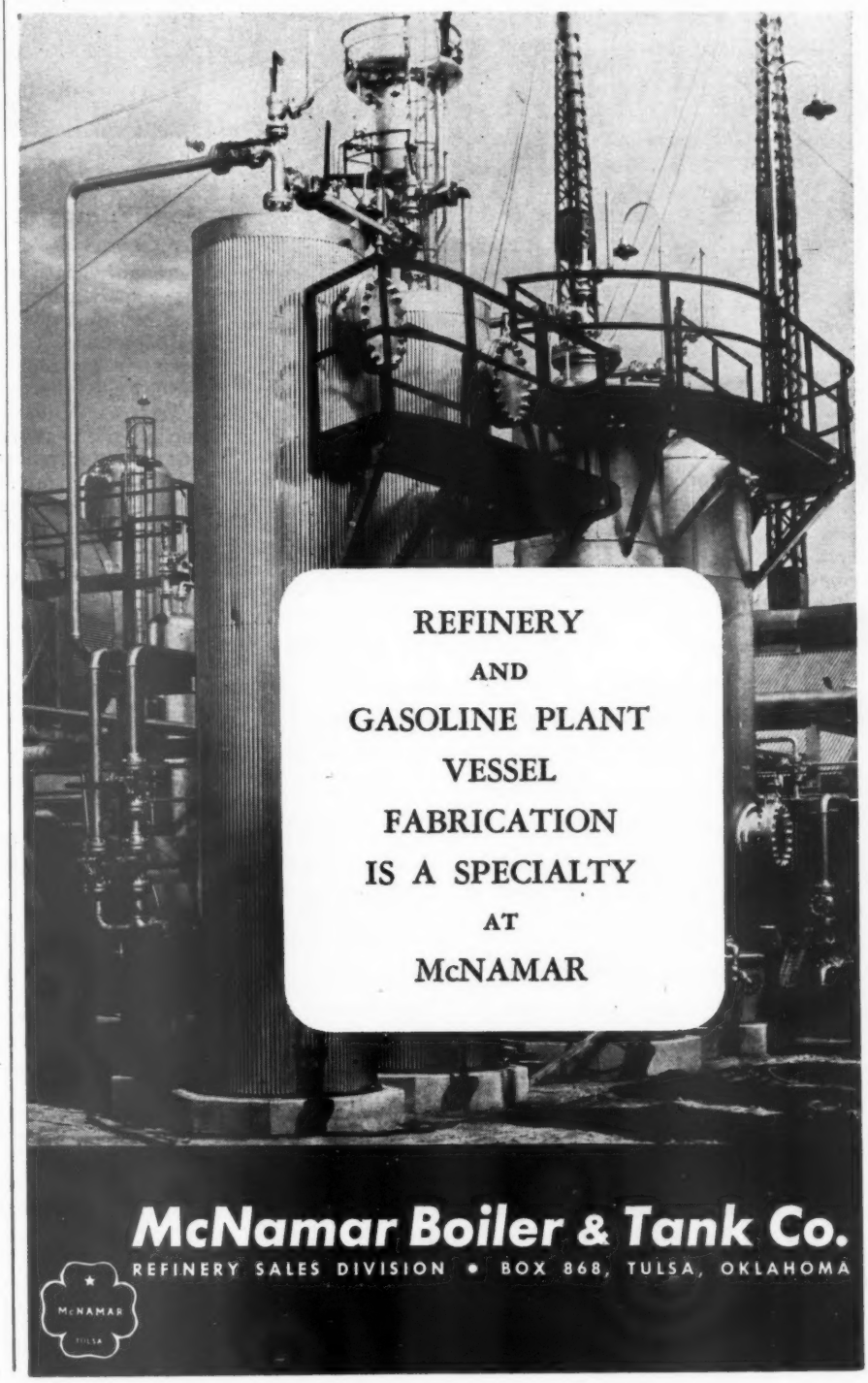
Johnson was employed in the law and patent department of the General Electric Company in Washington, D. C., prior to joining Ethyl. As an attorney in the Ethyl patent section, he will be responsible for executing patent applications dealing with exploratory and basic research conducted at the research laboratories.

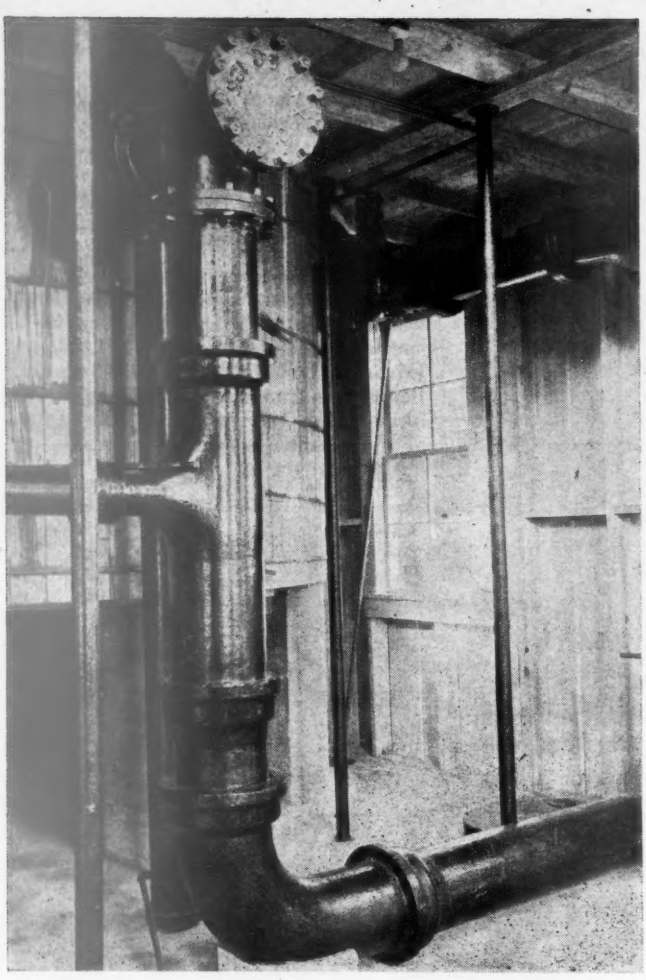
Professor Vladimir N. Ipatieff, director of chemical research for Universal Oil Products Company and director of the Ipatieff high pressure and catalytic laboratory, department of chemistry, Northwestern University, has been notified that he has been awarded two high honors of France. They are in recognition of his work in aviation gasoline "which enabled production of a special gasoline, so widely used to win the last war, at the time most critical for France."

Professor Ipatieff has been named a Chevalier of the Cross of Lorraine and Companion of the Resistance, the top distinction of the knighthood. He is the 40th person and the 12th American to receive the cross. General Eisenhower, scientist A. H. Compton, and the late President F. D. Roosevelt are among the other Americans who have been awarded this honor.

Dr. Warren F. Faragher, technical advisor to the vice president for research and development of Houdry Process Corporation, was one of 12 industrialists who received awards from the department of the Army for their investigations and contributions to the World War II effort in the field of industrial intelligence.

A certificate of appreciation signed by Frank Pace, Jr., Secretary of the Army, was presented to Dr. Faragher in a special ceremony recently by Colonel Edwin M. Sutherland, chief of the Pennsylvania military district, in recognition of his services as an investigator of the German fuels and lubricants industry near the end of the last war.





DIRECT ROUTE TO LOWER PLANT MAINTENANCE

The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

A relatively low first-cost material, cast iron pipe is usually cheapest in the end, for many refinery applications, because of its stubborn resistance to corrosion. Available with bell-and-spigot, plain end and flanged, or with standardized mechanical joints.

Cast Iron Pipe Research Association,
Thomas F. Wolfe, Engineer,
1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

Heat pump

Heat Pumps in Trial Service

In the winter of 1950-51, a 3-hp, air-to-air heat pump was thoroughly tested, primarily for mechanical performance. With that experience in hand three new units—two 5's and a 3—incorporating several improvements were built. These are in actual service in homes in Florida, Texas, and Virginia this winter to accumulate heating and cooling performance under various conditions of weather.

Tests on the earlier unit show that the frosting problem is not as serious as was thought it might be. Thus, it is not necessary to apply heat at low temperatures to prevent frosting. Also, it is found that the practical limiting temperature of operation is not around freezing but that the unit can be operated continuously down through zero—but with declining heat delivery, of course. If heat delivery reaches a predetermined minimum, resistance heaters provide additional heat to maintain comfort.

In these heat pumps a single thermostat determines whether the heat pump is used to cool the room air, to warm it, or whether supplemental heat from the resistance elements is needed. The pump operation is changed from heating to cooling by a simple four-way automatic valve. Because this valve employs slots in a piston it offers almost no restriction to gas flow compared with valves employing valve stems and seats to uncover ports.

Netherlands Firm to Make Synthetic Catalysts

A Netherland's chemical firm will become continental Europe's first producer of synthetic Fluid cracking catalyst for the petroleum industry under terms of a contract signed recently with American Cyanamid Company. The firm, Koninklijke Zwavelsuurfabrieken ("Ketjen") of Amsterdam, will manufacture Cyanamid's microspheroidal cracking catalysts, using Cyanamid's patents and processes, for Western European oil refiners. The catalysts are used in making high octane fuels, raw materials for synthetic rubber, and other vital petroleum products.

Keyed to a continent-wide expansion of refining facilities, production of the catalysts will begin early in 1953 and will be sufficient to handle an annual refining capacity of more than 56,000,000 bbl of crude oil.

The plant now being constructed by the Netherlands firm is designed to permit ready expansion to meet increased demands expected to result from still further refining growth on the continent.

The catalyst to be made by the Netherlands firm will be a silica-alumina fluid cracking catalyst consisting of minute pourous spheres about two thousandths of an inch in diameter.

PIPE LINE OUTLOOK ENCOURAGING

Industry's leaders give views on what 1952 promises in the way of expansion

What are the expansion prospects of the pipe line industry for 1952?

To obtain an answer to this question, *The Petroleum Engineer* asked a number of the industries leaders to give their views. Detailed answers are given below, but if a one-word summation of the outlook were desired, that word might well be "encouraging". The desire to construct numerous pipe lines exists, the supply of steel being the ultimate factor in determining to what extent proposed programs can be carried out. It is encouraging, however, that allocations of steel for pipe line use were increased considerably for the first quarter of 1952. If this trend can be maintained, it most certainly will be cause for rejoicing.

It is pointed out that the gas industry will spend $1,300,000,000 for construction purposes during 1952, a large part of which will be for pipe lines.

Already approved for 1952 are 4000 miles of crude oil lines and 2000 miles of products pipe line, to cost $240,000,000, and others doubtless will be approved during the year. In addition, there will be numerous small diameter pipe lines laid with reclaimed pipe.

Here is what outstanding men in the pipe line industry think:

J. L. BURKE

President, Service Pipe Line Company

"The pipe line industry will continue, as in the past, to serve the producing and refining sections of the oil industry to the full extent of its ability. Its ability to adequately serve is dependent upon several factors beyond its control, the most important being availability of materials.

"All indications are that more oil will be produced, transported, and refined in 1952 than ever before in the history of the oil industry. From a transportation standpoint, this will have to be accomplished in the face of tremendous odds and substantial material shortages.

"PAD's rock bottom steel requirements for the oil industry for the first quarter of 1952 were reduced 20 per cent by the Defense Production Administration. PAD is doing a magnificent hard-hitting job but if allocations of material to it continue to be reduced, the industry's task of maintaining adequate supplies will be almost impossible to accomplish.

"The problems of big inch pipe for large trunk line projects have gotten most of the headlines. The outlook for small sizes of pipe for gathering system extensions and lease connections is even more critical. New oil wells and fields cannot contribute to needed crude oil supplies unless they can be connected by gathering lines. The critical shortage in small size pipe was overcome in 1951 by salvaging and re-laying older second-hand pipe, but the industry is scraping the bottom of the barrel. A serious shortage of pipe for gathering lines may come in 1952 unless additional new pipe tonnage is made available. It must not be overlooked that it takes small lines to fill big ones."

D. A. HULCY

President, Lone Star Gas Company

"In these times, any one who attempts to predict in precise terms, even in regard to a period of time immediately ahead, is laying himself liable to the prospect of being shown to be a poor prophet. This would seem to be particularly true in respect to the gas industry because of the many factors which enter into the situation which affects expansion plans and activities, and because of the tremendous growth which has been generated within the industry within the last five years in comparison with the rather modest rate of growth which had been achieved theretofore.

"Fortunately, the results of studies and surveys by the American Gas Association provide authoritative figures reflecting historical growth in the industry over a period of years and also give the composite of the projections by individual companies of the expansion anticipated for a few years in the future. In the past, these projections have proved to be reasonably close to what actually materializes.

"This history reflects that during the 15-year period ended December 31, 1950, a total of approximately $5,100,000,000 was expended for construction of facilities within the American gas industry. It is significant that nearly 80 per cent of this total was expended during the last five years of this 15-year period. It is also significant that, on the basis of a breakdown of the figures for 1950, over 98 per cent of the total expenditures were made in connection with natural gas and mixed gas operations, leaving only a relatively small amount which was spent for new construction in the manufactured gas and liquefied petroleum gas operations.

"Upon the basis of projections that seem to have been largely confirmed by developments, new construction expenditures in the gas industry for the year 1951 will have been approximately $1,500,000,000. The projection of the amounts anticipated to be required by the gas industry for construction expenditures for 1952, is a total of approximately $1,300,000,000. Barring extraordinarily stringent conditions in reference to availability of materials, it would appear quite likely that the above figures representing projections will prove to be reasonably well within the limits of expectancy.

"There could be little doubt that this situation of recent and contemplated immediate growth, which could be described as phenomenal without exaggeration, has been compounded out of the effect of two principal factors. These are: (1) The development of gas reserves in quantities which seemed to be sufficient to justify the expansion of gas operations, and (2) the existence of an almost insatiable demand for gas service, particularly in some sections of the country, which results from the fact that gas service generally is provided at a

EXCLUSIVE

cost which is far less than that of any competing fuel, entirely aside from other elements of desirability in regard to gas as a fuel.

"In view of all of this and of other elements of the situation which apply, it is quite evident that construction operations in the gas industry, of which a large portion will be made up of pipe line construction, can be expected to reach a total for 1952 that will be larger than any prior year, except for 1951, which apparently will be an all-time record. As I have already said, this statement can be expected to be borne out by experience providing steel pipe and other necessary materials are available in the required quantities to support such a construction program.

"Just as we know the case to be in many other segments of industry in this country, we can anticipate construction and expansion of operations in the gas industry to be at near record levels during 1952. On the basis of all we can foresee, we must expect a very busy period during that year."

W. C. KINSOLVING

President, Sun Pipe Line Company

"It is not too difficult to predict the new crude oil and products pipe lines that will be laid in 1952, as this activity is entirely dependent upon pipe allocations made by the PAD, and, unless the line pipe situation materially changes during the latter part of 1951, the pattern for construction for next year is already set.

"The pipe allotments for the fourth quarter of 1951 have already been announced, and in an article appearing in the *New York Journal of Commerce*, datelined Washington, November 28, it is announced that the first quarter allotments for 1952 have been set for 10 major crude oil pipe lines and five refined products lines. Although this release does not mention the projects specifically, most of them are merely continuations of projects already approved and announced for the fourth quarter of 1951.

"As practically all of these projected lines have been mentioned in the various trade journals, there is no need to repeat them here, but the total mileage of crude lines already approved for 1952, some of which are under way, is approximately 4000 miles, and products pipe lines that have been approved approximate 2000 miles. The total cost of these projects has been estimated to be $240,000,000 and they are calculated to add approximately 1,290,000 bbl daily of crude oil and product transportation.

"In addition to these projects, which all contemplate the use of new pipe, a considerable mileage will be laid of small-diameter used and reclaimed pipe released by the construction of the various big-inch projects. Most of these will be products pipe lines. Some lines will be reconditioned and converted to products lines in places, such as The Texas Company line from Port Arthur across south Louisiana. The use of second-hand line pipe and the conversion of lines from crude oil to products will, of course, be dependent upon the completion during the year of the large-diameter crude lines which will replace them.

"Undoubtedly there will be other lines approved by the PAD later in 1952, but it is believed that most of the major projects for next year have already been approved. A possible exception is the 1952 approval of a large-diameter crude line from the Alberta fields of Canada to the West Coast at some point near Seattle. There is also an urgent request in for the approval of a products line from the Houston-Beaumont area to around Cincinnati, but up to the present time it is not known whether this project has been looked upon favorably.

"As stated above, all pipelining during 1952 is entirely dependent upon the availability of line pipe. A large demand for additional lines still remains, particularly in the products and LPG fields, and this demand will not be satisfied until the pipe situation eases up.

"Very little has been done so far to satisfy the demand for LPG transportation and it is predicted that there will be many miles of such pipe lines built as soon as pipe is available. Of course, there is also a large unsatisfied demand for products pipe lines, since the PAD's approval of projects at the present time is based upon absolute defense needs and not upon economical transportation factors. Many places remain where, from an economic standpoint, only the products pipe line can answer the need.

"With the construction of the various large-diameter crude oil lines projected for 1952, a great deal of the demand for crude pipe line capacity will have been cared for. There is no question, however, that when further development of the Williston Basin has taken place, a pipe line outlet of undetermined capacity will be needed from there to the refining areas. There is also a strong likelihood that a large-diameter line will be laid from the Alberta fields eastward, bypassing the Great Lakes, thus eliminating the large build-up of winter storage at the head of the Lakes and the attendant lake transportation. It is felt, however, that the latter plans cannot be carried out until after 1952 and until more pipe is available."

T. S. JOHNSTON

President, Interprovincial Pipe Line Company

"I am outlining the expansion program at present under way and planned for next year by Interprovincial Pipe Line Company and its wholly owned subsidiary, Lakehead Pipe Line Company, Inc.

"At the present time Interprovincial is adding five pump stations to its system, as well as building an additional 2,600,000 bbl of storage at Superior, Wisconsin, which will increase total available tankage at the terminal to 4,400,000 bbl. This work will be completed by the opening of navigation on the Great Lakes in 1952. The construction that is being carried out this year will provide ample capacity to take care of a peak summer movement out of Edmonton of approximately 113,000 bbl per day. With reduced pumping during the closed season of navigation, the year-round average throughput from Edmonton will be approximately 100,000 bbl per day.

"Deliveries to Superior for tanker movement to Ontario markets will amount to some 18,000,000 bbl in 1952.

"The 1952 expansion program provides for looping 100 miles of the 16-in. section of the system between Regina and the International border. One additional pump station will be added to the American section of the line at Deer River, Minnesota, and further storage will be built at Superior to bring the total available tankage up to 7,000,000 bbl. The entire program is scheduled for completion by the time navigation opens in 1953.

"These additions planned for 1952 will increase the summer capacity from Edmonton in 1953 to a maximum of 146,000 bbl per day and 95,000 bbl per day into Superior. However, the actual quantity delivered to Superior will depend on the availability of tankers. The above potential is somewhat in excess of today's tanker carrying capacity."

JAMES B. BLACK

President, Pacific Gas and Electric Company

"The phenomenal growth of California in the last decade—a population increase of 50 per cent and vast industrial and agricultural development—will continue in 1952, but at a somewhat lesser rate, according to our engineering estimates.

"In the six postwar years Pacific Gas and Electric Company has invested more than $800,000,000 in expanding its gas, electric, and other facilities to serve the growing demands for utility services in Northern and Central California. This postwar investment will pass the billion dollar mark during 1953.

"As of January 1, 1952, gas department expansion costs since V-J Day will total $167,310,000.

"During these six years our annual sendout of gas has increased 41 per cent. The rate of load growth has been 9 billion cubic feet a year, and the increase in the number of gas customers has been approximately 45,000 a year.

"In order to meet customer requirements and to build satisfactorily ahead of demand, our expansion program in both gas and electric departments will continue at a rate of about $150,000,000 a year.

"In 1952 expansion in our gas department alone will total $26,030,000, of which $22,000,000 is for line expansion and construction. Pipe involved in these projects will require approximately 60,000 tons of steel, two-thirds of it for transmission and major distribution improvements, and the remainder for routine distribution mains and service lines.

"The extent to which we will accomplish this necessary expansion will depend primarily on the amount of steel we are allotted by the Petroleum Ad-

ministration for Defense, and secondarily by the extent to which suppliers can fill authorized orders.

"At this writing we have received authorizations for only 75 per cent of our first quarter requirements for pipe up to 4½-in. diameter, and no authorization for pipe of 6-in. diameter and larger.

"The outlook as to steel allotments after the first quarter is quite uncertain.

"Gas is a universal fuel for house heating in California. Nearly a million homes are served in our territory alone. Because of the area's unique dependence on natural gas, we are hopeful that a substantial portion of our needs for pipe and other equipment will be duly authorized."

R. B. McLAUGHLIN

Chairman of the Board, The Texas Pipe Line Company

"There are now approximately 2000 miles of large diameter pipe line approved, and construction work either began in the last quarter of 1951 or will begin during the first quarter of 1952. The actual construction of these lines will extend through the greater part of the year 1952. What work will be undertaken in addition thereto, of course, depends on the availability of line pipe. As pipe does become available, it is reasonable to anticipate the construction of numerous products pipe lines, however, in my opinion, little if any of this work will be undertaken during the year 1952."

CLAUDE A. WILLIAMS

President, Transcontinental Gas Pipe Line Corporation

"National defense requirements seem likely to limit natural gas expansion in 1952. Reserves should gain.

"Steel during 1952 is bound to be in short supply for civilian needs. Only new natural gas mileage absolutely essential for rearmament purposes has much chance of getting steel pipe. Without steel pipe there is no opportunity for significant natural gas expansion.

"Demand for natural gas would seem likely to grow in 1952. Civilian markets such as New York City where natural gas is still new will want more. Industries tied in to national defense work in all probability will want more natural gas.

"Gains in load factor and in operating efficiency for the natural gas industry in 1952 seem likely. With the demand rising and facilities for providing more gas restricted it seems natural to expect that transmission companies will make greater use of natural gas storage, added horsepower, and refinements in operating techniques. Distributing companies may be expected to make greater use of storage, peak shaving, and improved operations.

"The sustained high level of exploration and drilling for oil and gas seems likely to carry on into 1952. Consequently natural gas reserves should continue to gain in 1952."

S. B. IRELAN

President, Cities Service Gas Company

"In my opinion, 1952 will present a genuine challenge to the natural gas industry—one that will require constant foresight and ingenuity adequately to meet. Due to the rapid growth of large population and industrial centers and the excessively low price of natural gas compared with other fuels, market demands for it have far exceeded the most liberal estimates to the extent that all phases of the industry — production, transportation, processing and marketing—have been unable to keep pace. World conditions demand, however, that we make every possible effort to meet all essential requirements for our commodity.

"The procurement of materials and equipment necessary for additional facilities and the time required to obtain approvals have presented further difficulties and handicaps to quick action to keep abreast of the constantly changing scene.

"Cities Service Gas Company expects, in 1952, to improve its facilities to meet firm load peak-day requirements to the best of its ability under the difficulties imposed by current conditions with reference to materials and equipment by the expenditure of some $8,000,000. The facilities so provided will fit into a longer range program that we have constantly before us, and which necessarily must be revised frequently to meet forecasted firm demand increases."

E. F. MORRILL

President, Mid-Valley Pipeline Company

"Our own expansion program of installing 40,000 hp at our existing stations and new booster stations should be completed early in 1952. We do not, however, anticipate the need for this additional capacity until the completion of the West Texas Gulf Pipe Line Company's new line.

"From an industry standpoint we are, of course, all encouraged by the recent improvement in allocations to oil lines obtained through various people in PAD and the industry. If it is possible to keep these allocations up for 1952 we should see the completion of several major projects and ones which are of strategic importance to the rapidly expanding pipe line system in the United States."

A. N. HORNE

President, Trans-Northern Pipe Line Company

"Pipe line construction in Canada for 1952 is wholly dependent upon the general steel situation.

"In Eastern Canada a 10-in. and 12-in. products line is under construction from Sarnia to Toronto, and is scheduled for completion in 1952, if steel is available.

"A 10-in. products line from Montreal to Toronto and Hamilton, with a 6-in. branch line to Ottawa is acquiring right-of-way and ordering pumping station equipment, but its actual construction is still dependent on availability of steel.

"In Western Canada, in addition to necessary gathering and feeder lines, a large diameter crude line to the West Coast is indicated, but availability of steel is the controlling factor.

"Several long distance, large diameter gas pipe lines are in the planning stage, but these are governed by proven reserves, Provincial Export restrictions, as well as steel.

"Pipe line construction in Canada is necessarily limited to about 7 months out of the year, which is a definite limiting factor under any condition."

JOSEPH L. SEGER

President, Interstate Oil Pipe Line Company

"Our company is now moving crude oil in record volumes. We anticipate that the company's crude deliveries during 1952 will be equal to and perhaps in excess of 1951. Substantially all portions of our system are operating at capacity and we think this condition will continue in 1952. Parts of our system, notably in south Louisiana, are inadequate to meet the requirements of our shippers. In this area we plan, during 1952, to install approximately 115 miles of 16-in. line, 41 miles of 12-in. line, and various quantities of smaller pipe in order to increase capacities substantially.

"In addition to regular maintenance throughout the system, we will, in 1952, revise and modernize a major portion of our Shreveport-Baton Rouge trunk line. This will involve the construction of two new stations, the abandonment of four old stations, and the laying of approximately 33 miles of 20-in. pipe, 36 miles of 16-in. pipe, and 27 miles of 12-in. pipe.

"We believe the industry outlook is similar to Interstate's. There will be a continuance of the high volume movements experienced in 1951. Substantial sums will be spent both to secure additional capacity and to modernize old and obsolete facilities."

GROVE LAWRENCE

Vice President, Southern California Gas Company

"Demands for gas are expected to increase during the next few years. Our forecasts indicate that increased delivery capacity will be needed to meet firm peak requirements by the winter of 1952-53, and increased supplies of gas will be needed to meet firm annual requirements, sometime between 1956 and 1960, depending upon future growth and rate of decline of gas available from California sources.

"To meet the peak demand problem we plan to install approximately 10 miles of 22-in. pipe in our Coastal system, southward from Ventura, to increase deliverability from the Goleta storage project by about 100,000,000 cu ft per day. Pipe has been ordered, subject to receipt of an allotment from the PAD, and this project does not require

a certificate from the Federal Power Commission. We expect to construct this line in the fall of 1952.

"To increase our annual supply of gas, we propose to increase our purchases of out-of-state gas. This will require the construction of approximately 20 miles of 30-in. loop line in the system between the Colorado River and Los Angeles, together with the installation of a 5000-hp compressor station near Whitewater.

"Orders have been placed for the necessary pipe, the compressor unit, and related facilities. An allotment has been requested from PAD, which will not be acted upon until certificates are received from the Federal Power Commission. Hearing has been set by the Commission for March, 1952. A hearing in the matter has been held by the California Public Utilities Commission. It is hoped that construction work can be started in January, 1953.

"In addition to the above items, we plan to construct 12 miles of 20-in. loop line in our existing system between the Kettleman Hills field, and the distribution system in the Visalia-Hanford area, to meet increased peak day demand. This job will be done during the summer of 1952, if pipe is obtained."

O. Q. LOMAX
President, Humble Pipe Line Company

"Humble Pipe Line Company has no major plans for expansion. As a matter of fact, upon completion of the Gulf-Sun-Cities Service pipe line and the Rancho pipe line the present bottleneck from the West Texas area should be solved and there should materialize a surplus of pipe line capacity from the area.

"Any plans which we have at the present time are only in the talking stage, and whether or not they materialize will depend a great deal upon future developments."

J. J. HEDRICK
President, Texas Illinois Natural Gas Pipeline Company
Natural Gas Pipeline Company of America

"So far as the systems of Natural Gas Pipeline Company of America and Texas Illinois Natural Gas Pipeline Company are concerned, we are, even with the completion of the Texas Illinois line, still not able to serve adequately the tremendous demand for house heating in the markets which we serve, although the capacity of the two lines is approximately 884,000.000 cu ft of gas daily. The capacity of the Texas Illinois line is only in its initial stages of 374,000.000 cu ft daily, which may be expanded to 524.000.000 cu ft daily. I believe that within a short while we will be required to fully expand that system to its ultimate capacity and, even then, the house heating demand will not be satisfied.

"The only salvation I see, in not only our own pipe line systems, but in the other systems of the country, is in the finding of an adequate underground storage reservoir near the market. Our own companies have organized Natural Gas Storage Company of Illinois and studies to date indicate that an adequate storage reservoir of something in excess of 90,000,000,000 cu ft annually can be developed ultimately and, by the winter of 1954, minimum quantities of usable storage should be available. If this storage project is successful, and we have reached a point where we have no doubt that it will be a success, then the house heating demand can be satisfied for a long period of time in the future. I am quite sure that other pipeline companies have recognized the necessity for storage near the markets and, in many instances, efforts are being made to find such storage reservoirs, not only in abandoned oil and gas fields, but in salt water sands having the proper characteristics.

"So far as the expansion of the capacity of the Texas Illinois pipeline from 374,000,00 cu ft to 524,000,000 cu ft is concerned, the line is so designed that only additional horsepower and gas gathering lines to the fields will be required."

C. S. MITCHELL
President, Cities Service Pipe Line Company

"We feel that the demand for crude oil will increase during 1952. Cross country crude lines will be expanded in capacity as soon as steel can be secured and there are several new big-inch lines approved for construction as soon as steel can be made available. We feel that the greatest need at this time is for increased capacity for moving West Texas-New Mexico crude to the Gulf Coast. When this need is met and Platte Pipe Line is completed, steel will be needed for the Williston Basin. It is likely that Canadian crudes also will be seeking new outlets during the year.

"Gathering systems will be expanded and extended to new fields as needed, but since the present capacity of gathering systems is greater than the trunk line outlets there is not such a demand for steel in this field.

"It is doubtful that any appreciable quantities of steel can be spared for products pipe lines while steel is so scarce, but I am sure that we will see many products lines built in the near future."

HAROLD DECKER
President, Houston Pipe Line Company

"In my opinion the industry will continue its expansion at as rapid a rate as the availability of pipe will permit. The demand for natural gas is expanding and the need for new facilities should cause construction to continue at a very high level."

J. L. LATIMER
President, Magnolia Pipe Line Company

"It is my personal opinion that the outlook for the crude and products pipe line industry for 1952 depends in a large measure upon the availability of steel not only to lay pipe lines, but to drill wells and construct new refining capacity.

"I believe, from present indications, that construction of large domestic crude lines will begin to taper off in the latter part of 1952. By the end of the third quarter of the year, most of the large domestic projects will have been practically completed. There are some large products lines now under way, and as pipe becomes available there will be more of such lines under construction.

"Should the oil industry be called upon to provide additional refining capacity to meet an emergency, it follows that the pipe line facilities to carry crude to the new refining installations will be necessary to meet the demand.

"It is possible that a new crude line for Canadian oil will project itself in the picture during the latter part of 1952, or early 1953; and it is probable that more tonnage of pipe will be shipped abroad, principally to Venezuela and the Middle East.

"Steel must be available for the industry to be able to meet the growing demand for petroleum and its products. Of course, from a pipe line standpoint, steel must be available to move crude and its products anticipated in the expansion of operations throughout the oil industry."

C. E. FINNEY, JR.
President, Salt Lake Pipe Line Company

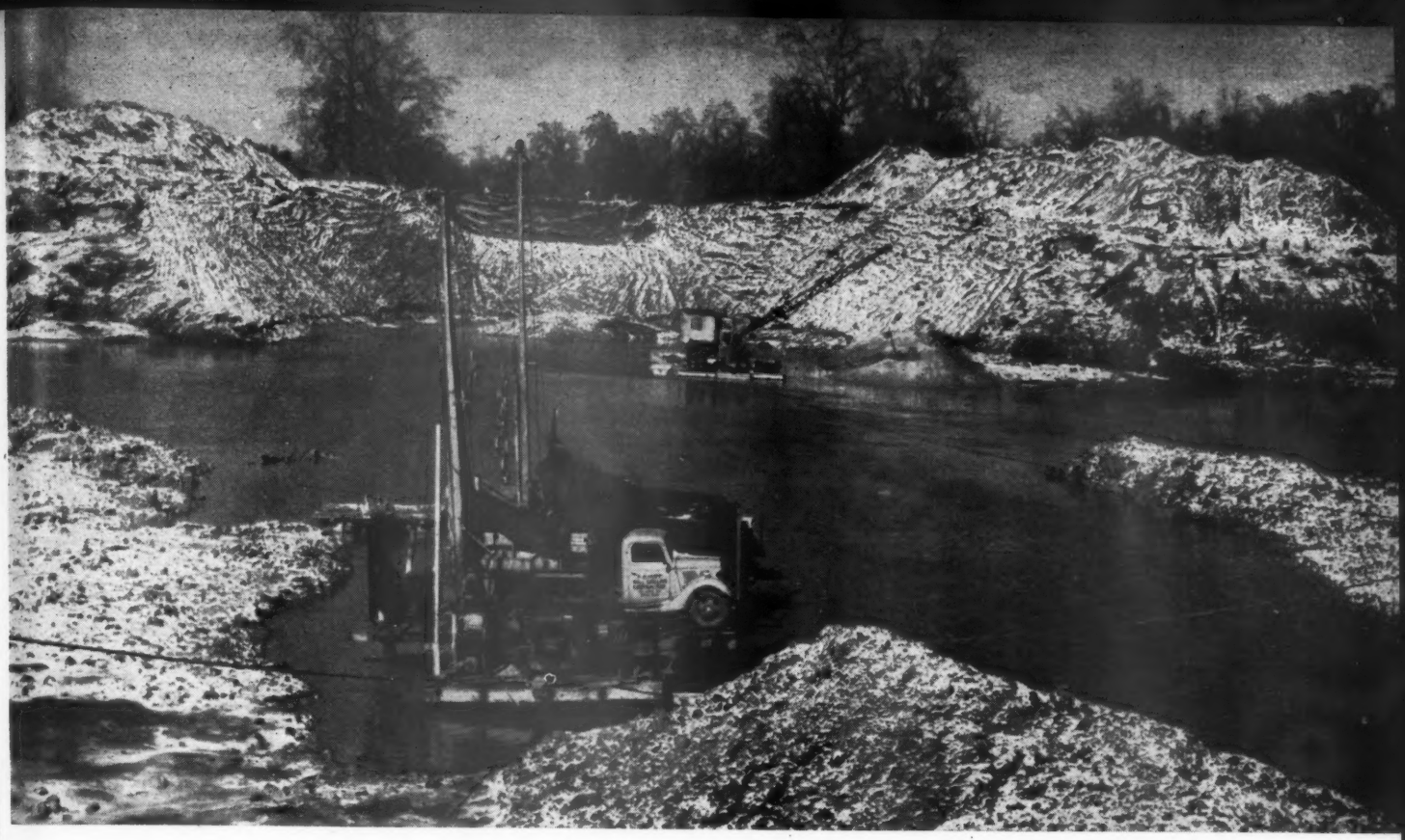
"We have no fully developed plans for expanding our pipe line systems in 1952. We are, however, making some studies for expansion of our crude oil line from Rangely to Salt Lake City, and our products line from Salt Lake City to Pasco, Washington." ★ ★ ★

Worthington Officials Attend Texas Illinois Ceremony

The "valve turning" ceremony at Joliet, Illinois, December 5, when the first natural gas was sent from Southeastern Texas to Chicago, was attended by executives of Worthington Pump and Machinery Corporation. Those attending were: C. E. Searle, vice chairman of the board; E. J. Schwanhausser, executive vice president; A. C. Ross, vice president; W. O. Wilson, commercial vice president; A. W. Fraser, midwestern district manager; W. C. Cheek, Chicago district manager; A. Traber, sales engineer, and H. C. Lehn, consulting engineer. This will be the second pipe line to Joliet from Texas, since the first line from the Texas Panhandle to Joliet has been operating since 1931. Both pipelines will feed into existing lines running from Joliet to Chicago.

Twenty-five Uniflow angle gas engine compressors were supplied by Worthington Pump and Machinery Corporation to the Texas Illinois Natural Gas Pipeline Company for this new line. In these engines, the through-scavenging system was adapted to pipe line gas engines for the first time. This system has long been in use in diesel engines and its adaptability to gas engines is the result of 7 years' research by Worthington.

★ ★ ★



Dredging the Trinity River in East Texas.

P 623.

Texas Illinois

Major Transmission System in Operation

This 1400-mile carrier is now moving gas from the Lower Rio Grande Valley of Texas to the Chicago area

FRANK H. LOVE*

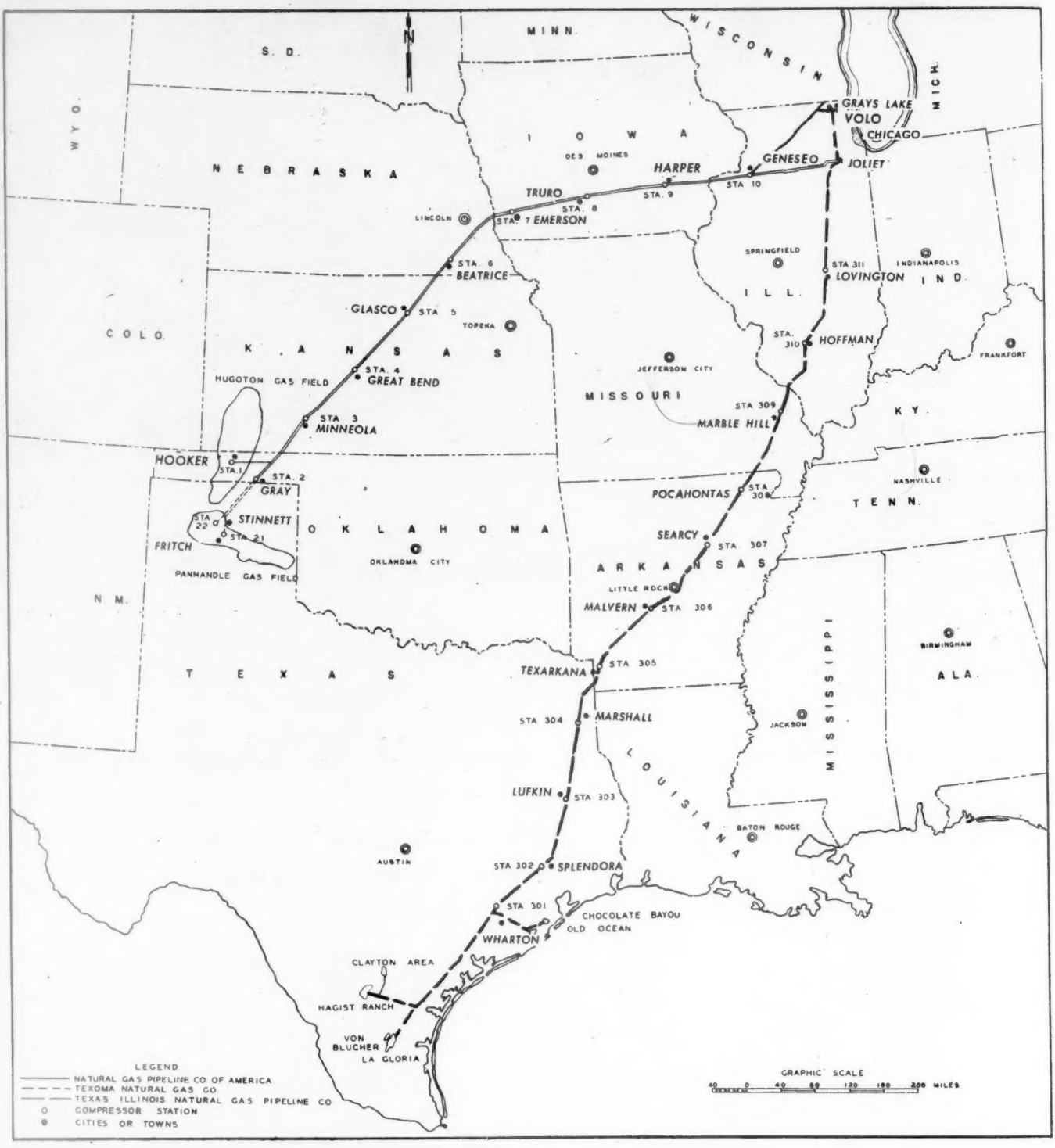
DURING December natural gas began flowing through another major transmission system—that of the Texas Illinois Natural Gas Pipeline Company. Originating in the Lower Rio Grande Valley of Texas, this carrier extends 1400 miles to the Chicago area, supplying gas to industrial and domestic markets. The first main line pipe was lowered-in September 7, 1950, the last October 20, 1951. The Mississippi River crossing, delayed by certain factors that will be discussed later, was the last tie-in. It was completed late in November.

Texas Illinois Natural Gas Pipeline Company was organized by Peoples Gas Light and Coke Company. Of the total volume of gas transported, 75 per cent is delivered to Peoples, the Public Service Company of Northern Illinois, and Northern Indiana Public Service Company. The rest is supplied to the Natural

*Editor, Oil and Gas Pipelining.

Inserting equipment inside pipe for X-raying welds.

EXCLUSIVE



System map of Natural Gas Pipeline Company of America, Texoma Natural Gas Company, and Texas Illinois Natural Gas Pipeline Company.

Gas Pipeline Company of America, also owned by Peoples, except for approximately 17,000,000 cu ft a day, which Texas Illinois is delivering to utility customers along its system in central and southern Illinois.

Texas Illinois is obtaining its gas supply from the Chocolate Bayou, Old Ocean, von Blucher, Tijerina La Gloria, Clayton-San Caja, and Hagist Ranch fields.

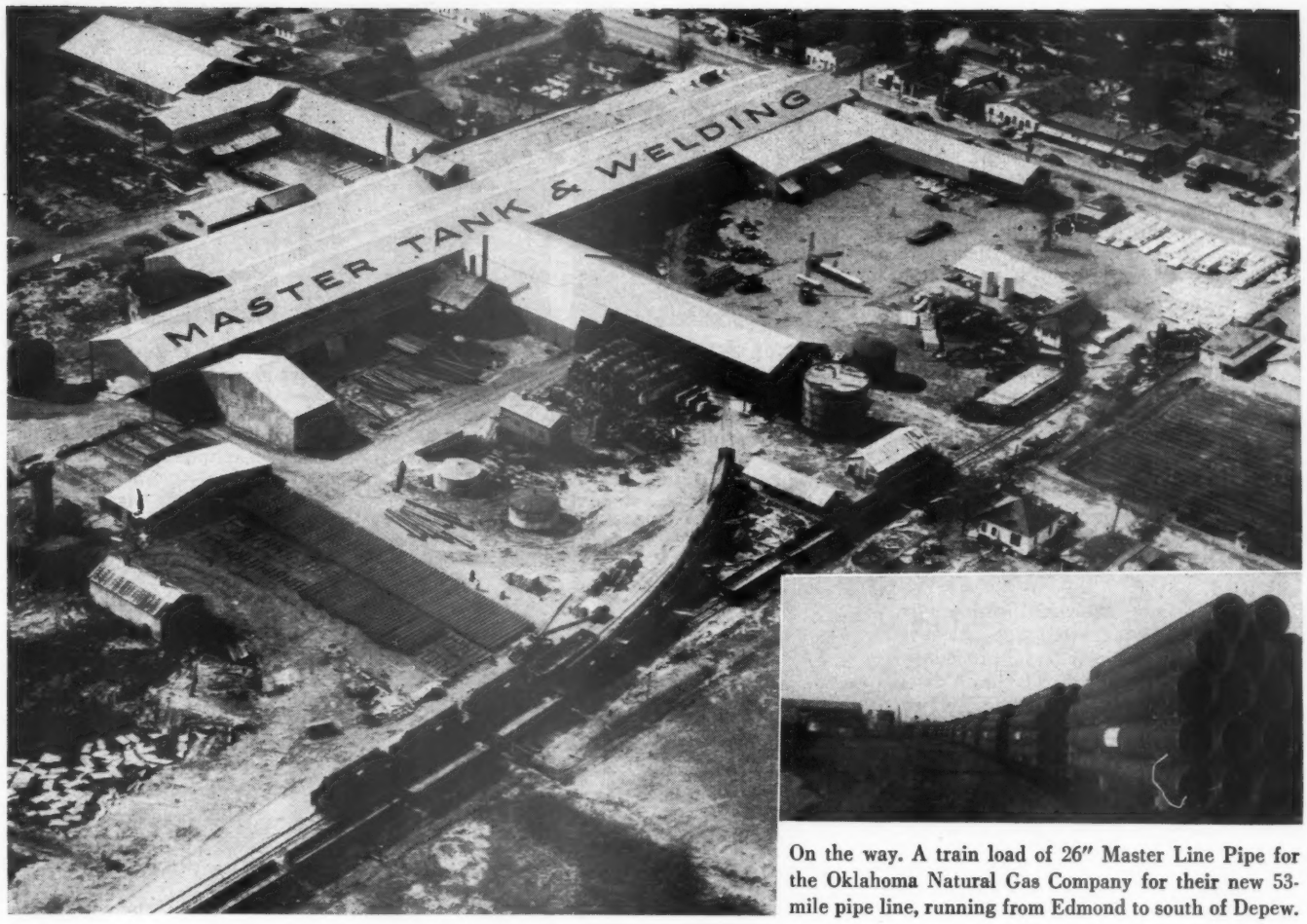
Total investment in this extensive system is $130,000,000.

Construction

Many considerations entered into the final selection of the right-of-way for the Texas Illinois Pipe Line. In the Texas coastal area sulfur production was a factor, in East Texas lignite and iron ore production, in Arkansas bauxite ores, in southern Illinois, coal, and in northern Illinois, commercial clays, Another matter of considerable consequence was soil subsidence in southeastern Missouri, identified as the sink hole phase of the Kimmswick limestone.

Production of sulfur results in surface subsidence, which would cause considerable difficulty to a pipe line laid across these sulfur domes. Lignite, iron ore, bauxite, coal, and commercial clays are recovered by the open pit method of mining, which precluded the location of a pipe line in such areas. The necessity of avoiding these troublesome obstacles meant that the route of the line had to be planned to miss them entirely.

Insofar as line construction was concerned, accepted methods of good prac-



On the way. A train load of 26" Master Line Pipe for the Oklahoma Natural Gas Company for their new 53-mile pipe line, running from Edmond to south of Depew.

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tice were adopted. A minimum cover of 42 in. was given the pipe, which was coated throughout with bitumen enamel and wrapped with glass fiber. The stove-pipe method of lining-up pipe joints for electric welding was employed. Field inspection of welds was thorough. About 20 per cent of the welds were X-rayed and visual inspection was given the rest by experienced inspectors. The line pipe came in 40-ft lengths with the ends beveled 37½ deg, which is a greater angle than customarily used but one that this company feels provides a better weld.

The 30-in. main line pipe has a wall thickness of 11/32 in. and weighs 108.954 lb per foot. The 26-in. pipe has a 0.312-in. wall and weighs 85.733 lb per foot, whereas the 24-in. has the same wall thickness and weighs 79.058 lb per foot. For crossing minor streams with a single line, as well as in corrosive soils, pipe having a wall thickness of 1.125 in. was used.

A feature of some significance was the use of steel-jacketed pipe in river and swamp crossings. This procedure was developed by the A. O. Smith Corporation and consisted of wrapping two sheets of steel around nominal line pipe to provide adequate negative buoyancy for submerged crossings. For example, the carrier pipe on 24-in. river pipe had a ½-in. wall thickness, and with two ¼-in. sheets wrapped around the carrier pipe, provided a joint of pipe with an overall wall thickness of 1 in. The multi-wrapped sheets were fixed in place by the submerged arc-welding process for both the seam and girth welds.

Another construction feature of great importance from a safe operating point of view was the installation, at approximately 10-mile intervals, of 30-in. main line welding end plug valves equipped with a gas-operated cylinder to provide

James F. Oates, Jr., is chairman and chief executive officer of the Peoples Gas Light and Coke Company and chairman of the board of Texas Illinois Natural Gas Pipeline. He joined Peoples Gas in 1948 in his present capacity, and was formerly an attorney specializing in public utility law.

Joseph J. Hedrick, president and general manager of Texas Illinois and Natural Gas Pipeline Company of America, has had almost 20 years service with the company. He joined the organization as general counsel, bringing with him some thirteen years of oil and gas industry experience.

Mark V. Burlingame, vice president in charge of operations for Texas Illinois and Natural Gas Pipeline Company of America, began with the latter company as a field inspector in 1930. A petroleum engineer, he has been associated with some phase of the gas and oil industry since 1926.

J. G. Dickinson, vice president in charge of production for Texas Illinois, has his headquarters in Amarillo, Texas. He joined Texoma Natural Gas, now Texoma division of Natural Gas Pipeline Company, in 1930 as superintendent of production, after wide experience in the gas industry.

Clayton E. Holmes is vice president in charge of sales for Texas Illinois and Natural Gas Pipeline Company. He joined the company in 1930 as a special problems engineer, and was elected to serve as vice president of Texas Illinois and Natural Gas Pipeline Company of America in 1948.

George P. Garver, vice president, secretary, and treasurer of Texas Illinois and Natural Gas Pipeline, joined the legal department of Natural Gas Pipeline in 1930. He was elected to the office of secretary and treasurer in 1946, and was named to serve as vice president in 1948.

Slatted pipe being carried into Arkansas River at Little Rock.

PIPE LINES OF *Satisfaction*

Congratulations to Texas-Illinois Natural Gas Pipeline Co. on its newly completed pipeline into Chicago.

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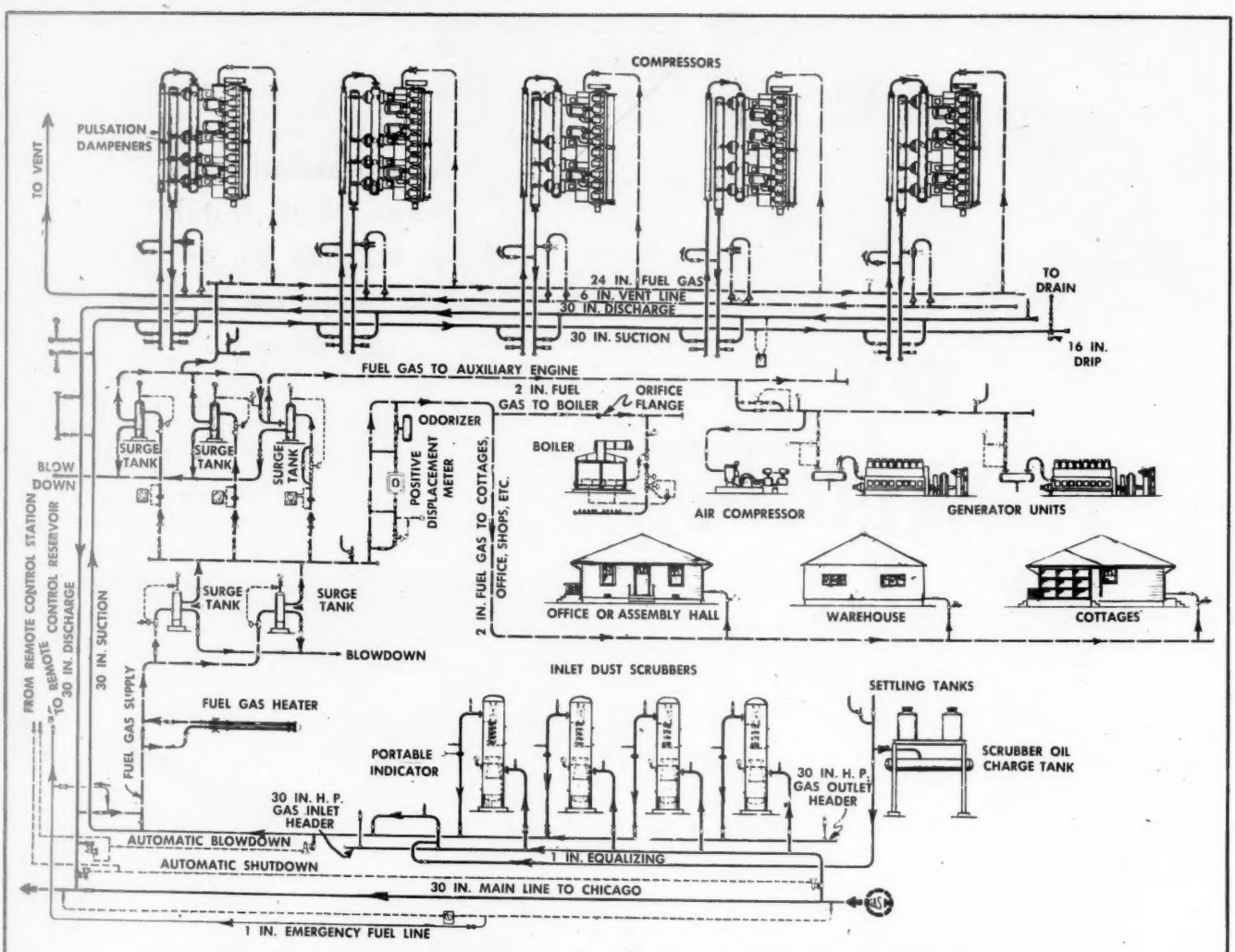


Compressor station gas flow diagram of Texas Illinois Natural Gas Pipeline Company.

Lowering-in a section of 30-in. pipe.

automatic closing in event of pipe line failure.

Through rocky areas not only was the trench padded, but special rock shield mats were secured about the pipe to give added protection to the coating. Casings were installed at all highway and railroad crossings in the standard manner. On the downstream side of each station drips were provided to remove condensate from the line. These were spaced 8 to 16 miles from the stations.

In all, seven major river crossings were installed. Four are submerged crossings and three suspension bridges. The submerged crossings are of the Illinois, Mississippi, Arkansas, and Trinity rivers. The suspension bridges are over the Colorado, Brazos, and Red rivers. Originally, the Mississippi River crossing was to have been a suspension bridge. Because several companies have had breaks in submerged crossings of the Mississippi, it was thought best to make this of the suspension type. A series of core tests at the site selected, however, revealed that, although good footing could be obtained on one side of the river, it could not on the other. There followed a search for a suitable location, but when one eventually was found time was growing short and it was

This section of pipe, with concrete weights and rock shields, was placed through a drainage canal in Arkansas.

necessary to install a submerged crossing to avoid a delay in placing the line in operation. This accounts for the Mississippi crossing being the last link to be made in the main line, as mentioned above.

Covering at major rivers was generally in the 9 to 10 ft range, with a minimum cover of 18 ft specified on the Arkansas River and 15 ft on the Mississippi. As a matter of fact the pipe was buried as much as 50 ft below the bed of the Mississippi River channel in some places.

The submerged crossings were all dredged and, except for the Mississippi, which was laid from a barge, the lines were floated and pulled into place.

The Mississippi River crossing was made near Cape Girardeau, Missouri, and consists of three 20-in. lines. The crossing is approximately 3000 ft wide.

The Illinois River crossing was near Morris, Illinois, and is about 1000 ft wide. Two 24-in. lines were laid here.

The longest crossing was of the Arkansas River at Little Rock—5000 ft. Two 24-in. lines were installed. In this instance the pipe was lowered to the bed of the river and the silt dredged from beneath it, allowing the line to settle to the desired depth.

The Trinity River near Livingston, Texas, although but 650 ft wide, presented some difficulty, as it has a rock channel that had to be shot. Two 24-in. lines were installed here also.

The enormity of undertakings such as these are difficult to visualize but are indicated by the fact that on both the Mississippi and Arkansas River projects in excess of 2,000,000 cu yd of silt were dredged. The Mississippi River project employed the largest dredge ever seen on the river. It was so large, in fact, that from the air it gave the appearance of completely spanning the river.

Heavy wall pipe was used on all river crossings. On the Mississippi the pipe has an outside diameter of 21¼ in. and a wall thickness of 15/16 in., weighing 203.378 lb per foot. Minimum yield strength is 52,000 psi. The approaches were laid of 20-in., ⅜-in. wall pipe weighing 78.6 lb per foot.

The 24-in. pipe on the Arkansas, Illinois, and Trinity rivers have an outside diameter of 25 in. and a wall thickness of 1 in. This pipe weighs 256.32 lb per foot and has a minimum yield strength of 40,000 psi.

The Colorado River suspension bridge is near Glenflora, Texas, and has a single main span of 550 ft. Although it carries a single line of 26-in. OD pipe at present, it is so constructed that another 26-in. line can be added at a later date if desired. The main towers are approximately 85 ft high and are founded

Coating and wrapping pipe on Schedule 5 in East Texas.

Making a road crossing on Schedule 13 in Illinois.

on concrete piers supported on steel piles. The superstructure is carried on two main cables, each having a diameter of 2⅛ in.

The Brazos River bridge is situated between Orchard and Simonton, Texas, and has a single main span of 750 ft. Here, again, although the bridge presently carries a single main span of 30-in. OD pipe, it is built to carry another if and when desired. The main towers are approximately 100 ft high and rest on concrete piers founded on steel piles. The two main cables of the superstructure are each 2¾-in. in diameter.

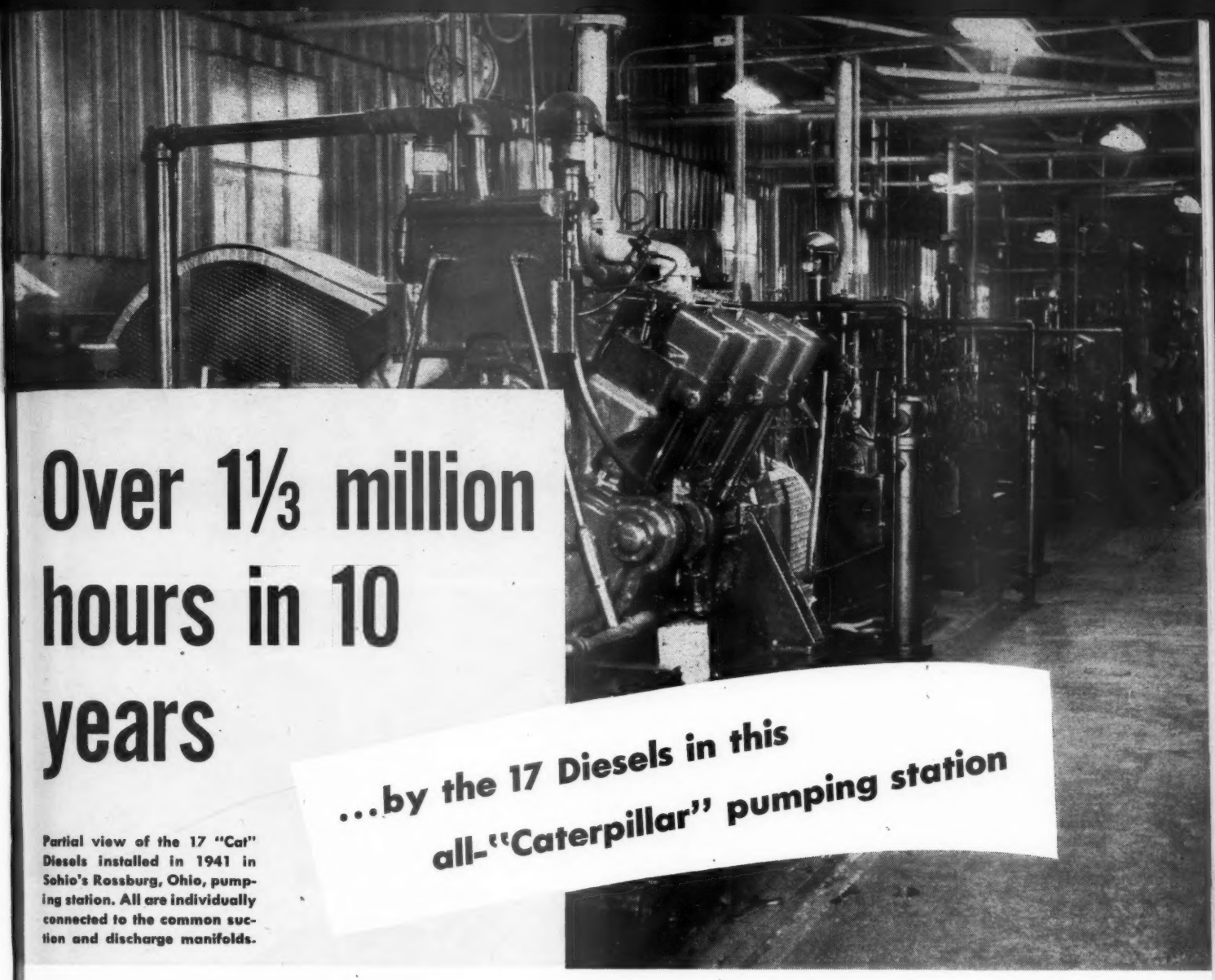
The bridge across the Red River is immediately downstream from Fulton, Arkansas. Two 30-in. OD lines were installed, the pipe having a wall thickness of 11/32 in. The main span, center-to-center of the main towers, is 1400 ft. The side spans, from the center of the main towers to the center of the rest towers, are 560 ft. The length of the suspended structure is 2520 ft, and the overall length of the structure is 3378 ft 6 in. Main towers are 156 ft high. The spread of wind trusses of each main tower is 225 ft. Each main tower weighs 320,000 lb. The height of the rest towers are 63 ft, and each weighs 50,000 lb. The combined breaking strength of the two main cables is 3,804,000 lb, and the breaking strength of each wind cable 576,000 lb.

All bridges are designed to resist a wind load of 120 miles per hour.

An important phase of the design was to build the bridges high enough that they would be above possible damage from debris floating down the river during flood stages. It was also necessary that they clear navigation. This latter is a specification of the U. S. Corps of Engineers. Additionally, lights were installed on all bridges as a warning to aviators, and the carrier pipe is protected by an aluminum paint that conforms to U. S. Navy specifications.

Initial testing of the line was between gate valves at a pressure of 400-450 psi, after first cleaning the interior by "pigging". Later a high pressure test was made, going to 900 psi on the 30-in. pipe

Sideboom tractors maneuvering a long section of pipe into position at Piney Creek crossing near Lufkin, Texas.



Over 1⅓ million hours in 10 years

...by the 17 Diesels in this all-"Caterpillar" pumping station

Partial view of the 17 "Cat" Diesels installed in 1941 in Sohio's Rossburg, Ohio, pumping station. All are individually connected to the common suction and discharge manifolds.

If ever a "case history" testified to the long life and continuous operation of "Caterpillar" Diesel Engines, this installation does so convincingly. Here, at the Sohio Pipeline Company's Rossburg, Ohio, station, 17 "Cat" Diesels (D17000s and D13000s) have been in active service for ten long, hard-working years. One serves as oil-change standby. Another is standby for overhauls, tune-ups and parts replacements. Thus, 15 engines are always running—24 *hours a day.*

Deducting down-time for overhaul (about every 5,000 hours per unit) and servicing, the group has rolled up approximately 1,400,000 engine hours. This does not include the fact that nine of these engines had seen service before being installed at the Rossburg station. Their further, unspent life still challenges an accurate guess!

Sound engineering and earnest manufacture are the basis for these Diesels' quality and sturdiness. Sensible care and maintenance have been the pay-off in their record of dependable performance. Yet, their history is but a reflection of the individual history of thousands of mates at work in the oil, mining, quarrying, contracting, lumbering, transportation, fishing and other industries.

A timely word: The finest machines are subject to wear—yet responsive to care. Good maintenance is doubly important today. There's nothing like stitch-in-time inspection to help obtain the long life built into your "Caterpillar" equipment. Call in your "Caterpillar" Dealer. Let him rebuild parts before excessive wear makes them unsalvageable.

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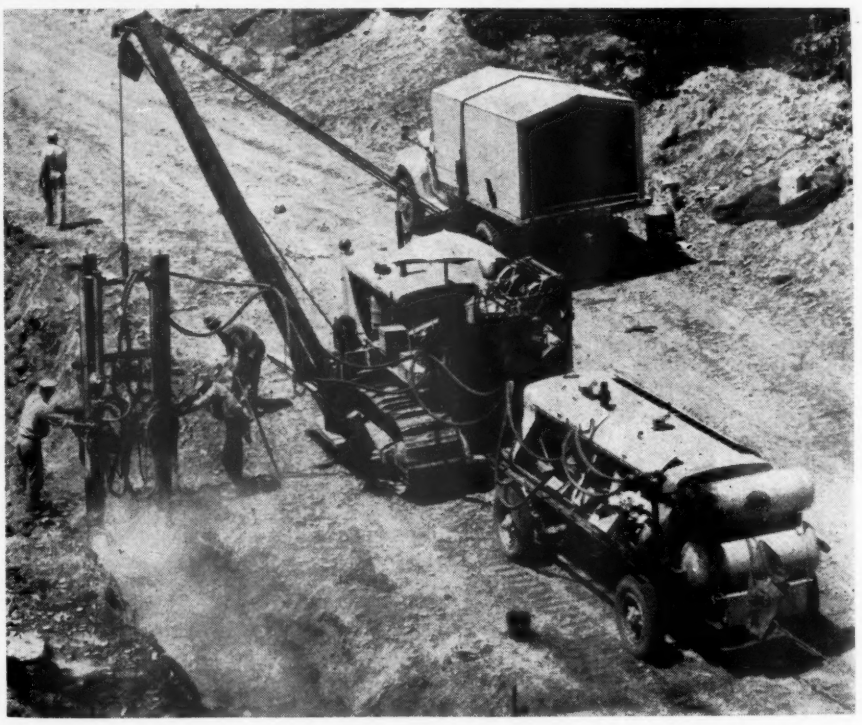
Oilfield Engines

Bending pipe on the famous King Ranch in South Texas.

Center, drilling shot holes in rocky area where the ditch had to be blasted.



and 950 psi on the 26-in. This testing was by sections, the pressure being brought up in increments.

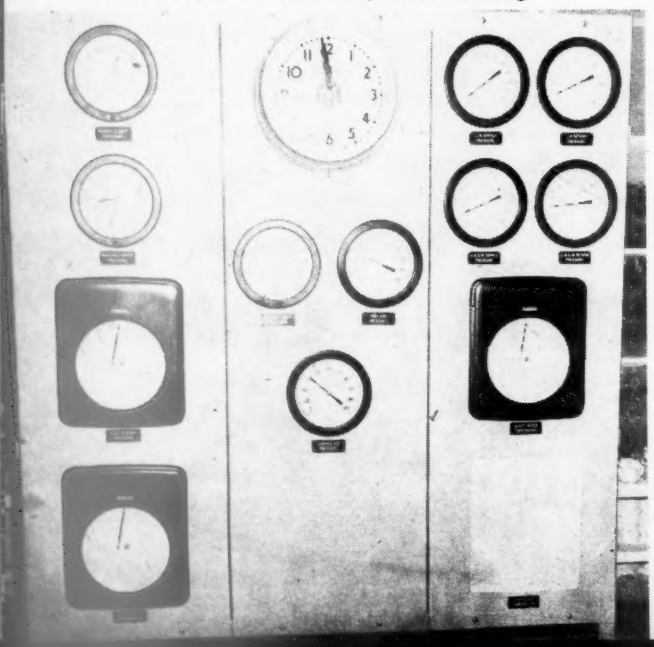
Compressor Stations

The system began operating with five compressor stations, erected at New Caney, and Marshall, Texas, Malvern and Pocahontas, Arkansas, and Centralia, Illinois. With these stations 374,000,000 cu ft of gas are being pumped daily. Six additional stations are planned for the future, which will bring the capacity of the system up to 524,200,000 cu ft a day. The six future stations will be at Hungerford, Lufkin, and Texarkana, Texas, and Searcy, Arkansas, Marble Hill, Missouri, and Hammond, Illinois.

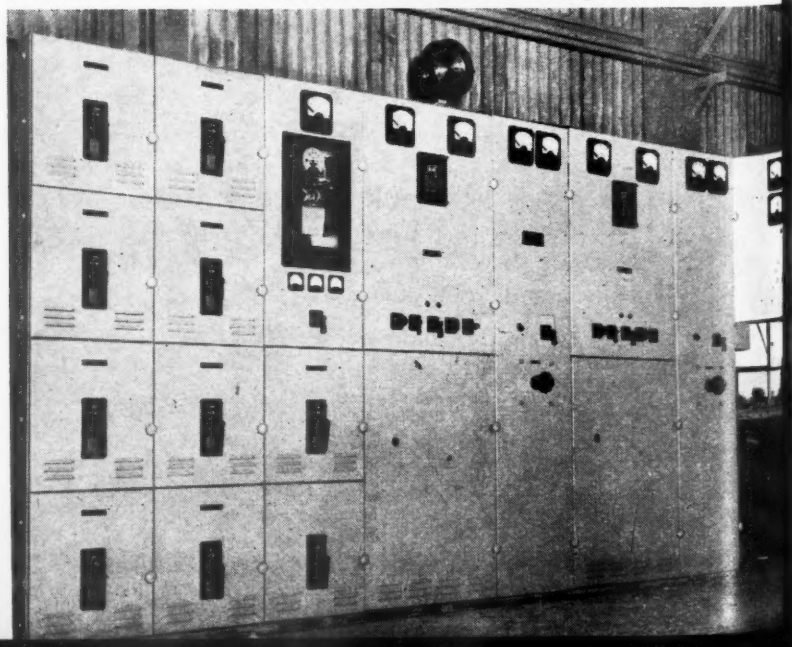
Operating pressures are 565 to 570 psi suction and 565 to 570 psi suction. The compression ratio is 1.5. Winter gas temperatures are 95 to 105 F on the discharge and 40 to 60 F on the suction. There is no cooling of the gas.

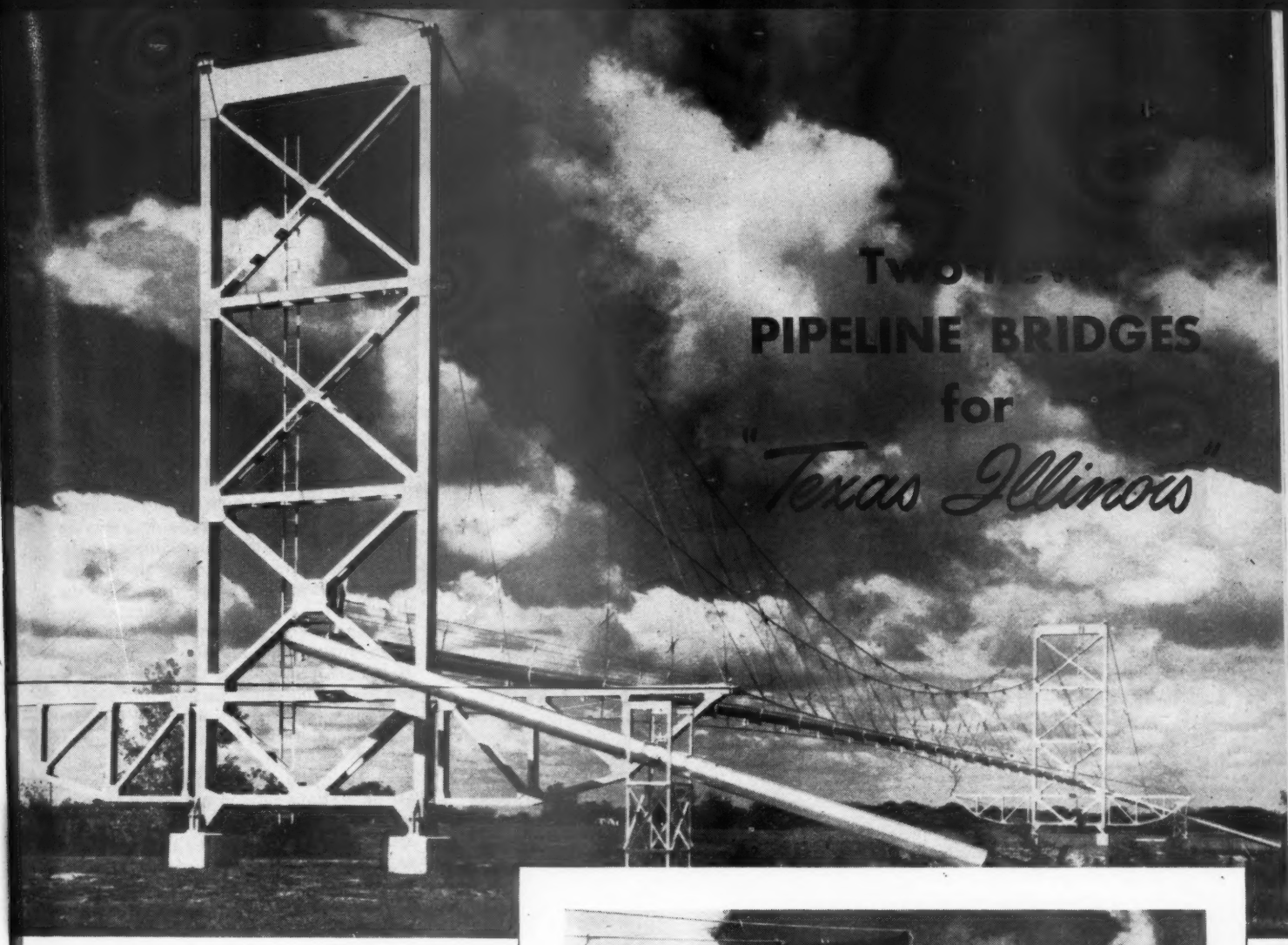
Each station is equipped with five 2000-hp, 10-cylinder, 2-cycle compressor units, on which the compressor cylinder bore is 11¼ in. and the stroke 16 in. Power cylinders are of the design, comparatively new in pipe line usage, that employs the scavenging principle known as Uniflo. In a 2-cycle engine employing this principle, the exhaust valves in the cylinder head open near the end of the power stroke to release the exhaust gas. Intake ports are uncovered as the piston continues on the downward stroke, admitting scavenge air into the cylinder and allowing it to pass straight through the cylinder and out through the exhaust valves without any reversal of air flow taking place. The manufacturers of the engines point out that this results in

Control board in main compressor building.



Generator controls and main power feeders.





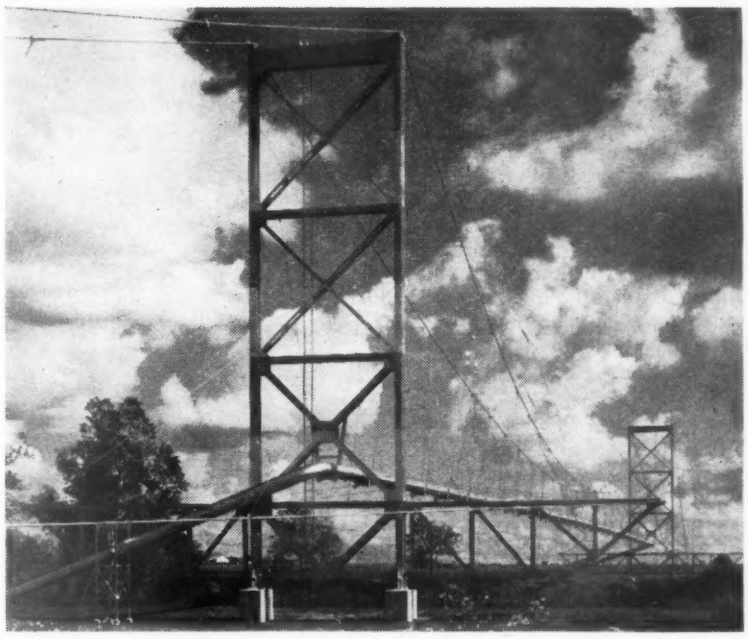
Two PIPELINE BRIDGES for "Texas Illinois"

Colorado River Bridge, near Glenflora, Tex., carrying Texas Illinois 26" O.D. gas pipeline. Main span of 550' has provision for a second line.

by

PITTSBURGH-DES MOINES

These two modern Pipeline Bridges were constructed by Pittsburgh-Des Moines for the Texas Illinois Natural Gas Pipeline Company, Chicago, Ill. Typical of the many stream crossings built by us for the great pipeline companies in recent years, these bridges exemplify our special capacity and experience in this field. Let us discuss your future projects.



Brazos River Bridge, near Simonton, Tex. 750' main span carries Texas Illinois 30" gas pipeline, and is designed for future additional line.

These bridges were designed by Matthews & Kenan, consulting engineers of San Antonio, Tex.

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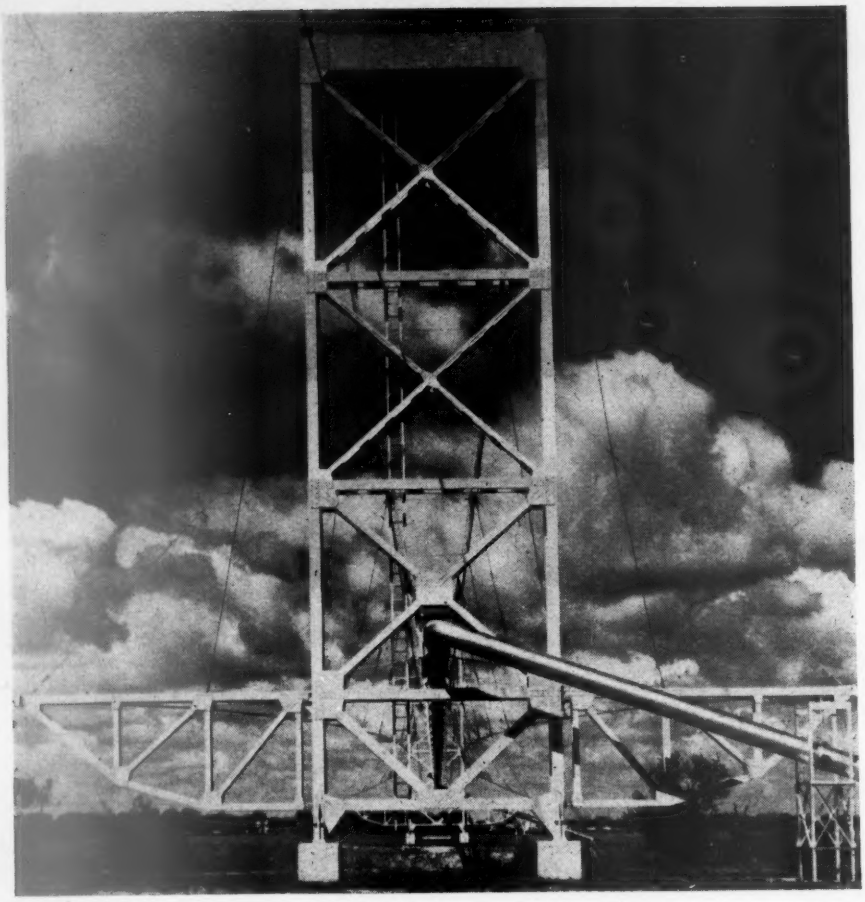


Suspension bridge over the Colorado River near Glenflora, Texas.

efficient scavenging of the cylinders and also makes it possible for the cylinders to be supercharged by an early closing of the exhaust valves.

Low compressor valve velocity of 2000 ft per minute was used in the design to minimize horsepower requirements. Cylinders and unloaders of proper size allow the engines to be fully loaded under all normal operating conditions. Bypass type oil filters are installed on each compressor unit.

The suction and discharge headers above and below the compressor cylinders were designed as pulsation dampeners. Fan type coolers are employed to cool engine jacket water, as well as for lube oil cooling. The two systems are entirely separate from each other. By means of automatic bypass valves the flow of water is controlled to maintain a constant inlet temperature, which is recorded in the auxiliary building. To circulate jacket water there are three centrifugal pumps rated at 3450 gal per min against a 50-ft head at 1150 rpm. These pumps are driven by 50-hp motors. Lubricating oil cooling water is circulated by three centrifugal pumps rated at 650 gal per min against a 37-ft head at 1750 rpm. These are driven by 7½-hp motors.

Each station generates its own electricity, and for this purpose there are two 610-hp gas engines that drive 500-kva a-c generators. The generators are 3-phase, 60 cycle units. The engines are 4-cycle and have a 13-in. bore and 16-in. stroke. The 610 hp is developed at a speed of 400 rpm.

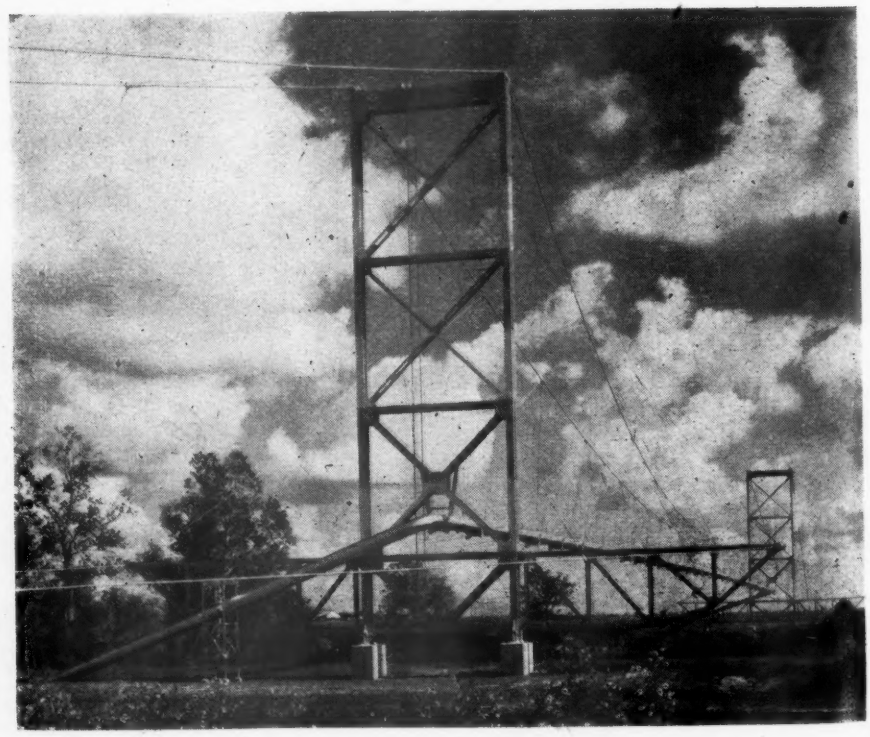
Suction and discharge lines and the manifold are supported on concrete piers, otherwise all pipe and electrical conduit is situated on overhead structural steel pipe supports. The extra cost involved is considered more than offset by the advantages gained. This design measurably reduces maintenance cost, simplifies testing, and brings all piping under constant visual inspection.

Because of its great importance to safety, high pressure piping in the plant area was installed only by the most competent welders, who had to pass a rigid test before being employed. They worked under highly trained inspectors, and, in addition, all field welds were X-rayed. Finally, the high pressure lines were given a hydrostatic test.

A further safety factor was the installation of emergency shutdown equipment. By remote control, side gates on the suction and discharge lines can be closed and the blowdown valves, situated near the side gates, opened to depressure the plant area. Further, engine ignitions are disconnected, shutting them down. The blowdown valves are 16-in. in diam, larger than customarily used, but the operating company feels that the larger size is important because of the acceleration it imparts to depressuring.

Steam is the medium for heating most of the stations now in operation. It also will serve for heating the majority, if not all, of the future stations. There are two exceptions in the case of the stations now in operation. Boilers were not installed at New Caney or Marshall, Texas. These buildings are heated by circulation of engine jacket water. Farther north, however, where the winters are more severe, boilers have been provided that are capable of maintaining

The Brazos River suspension bridge has a single main span of 750 ft.



Compressor Station Data

Station number	Location	Installed horse-power	Status
301	Hungerford, Tex.	—	Planned
302	New Caney, Tex.	10,000	Operating
303	Lufkin, Tex.	—	Planned
304	Marshall, Tex.	10,000	Operating
305	Texarkana, Tex.	—	Planned
306	Malvern, Ark.	10,000	Operating
307	Searcy, Ark.	—	Planned
308	Pocahontas, Ark.	10,000	Operating
309	Marble Hill, Mo.	—	Planned
310	Centralia, Ill.	10,000	Operating
311	Hammond, Ind.	—	Planned

a minimum temperature of 50 F in the main compressor building, 70 F in the auxiliary building, and 60 F in the regulator and meter building. In this system, steam is condensed and returned to a surge tank, from which it is pumped back to boiler feed. Space heating is employed in the main buildings, but in the regulator and meter building fuel gas is prevented from freezing in the runs by flowing hot jacket water through K-fin sections countercurrent to the gas.

Two wells were drilled at each station to provide water for plant operation and domestic use. These will produce 100 gal per minute or more and all are situated on the station site except at Centralia where it is necessary to bring the water in from a distance of four miles. The water can be used in its raw state to serve the fire systems of the plant and cottage areas, but is treated for softness and purity before being used in plant cooling systems, boilers, and domestically.

Prior to the beginning of station construction, soil tests were made to determine the thickness and size of concrete mats that would be required under the buildings and equipment. The main compressor building and the engine foundations are tied to these mats. Buildings are of rigid frame construction covered with corrugated asbestos, and are of the type that is reinforced at the corners and have a completely self-supporting frame. In the main compressor building crane rails are on either side and extend the full length of the building. At one end are truck loading and unloading facilities. The basement has sufficient headroom and is unusually well lighted.

In the auxiliary building are the electrical generating units, an engine-driven air compressor, a motor-driven air compressor, jacket water pumps, lube oil cooling water pumps, fire pump, lube oil transfer pumps, emergency raw water pump, machine shop, motor control center, switchgear, and tool room. To house a machine shop and tool room in this building necessitated approximately 1300 sq ft more floor space than ordinarily would be required. This was believed justified, however, as lower operational cost is anticipated.

The sizes of the various buildings are as follows:

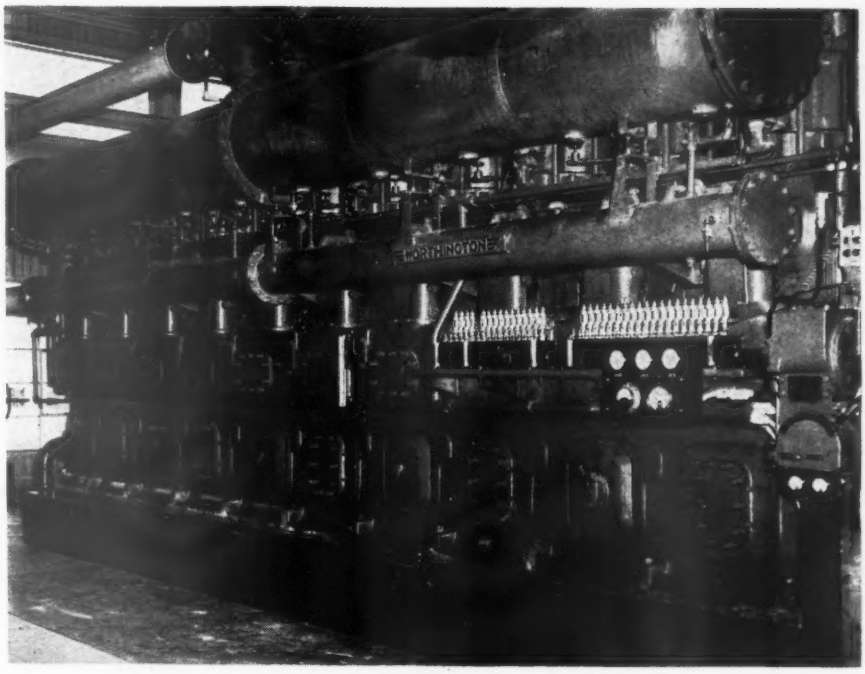
Main compressor building, 154 ft long, 48 ft wide, and 20 ft high.

Auxiliary building, 168 ft long, 48 ft wide, and 20 ft high.

Regulator and fuel meter building, 40 ft long, 22 ft wide, and 12 ft high.

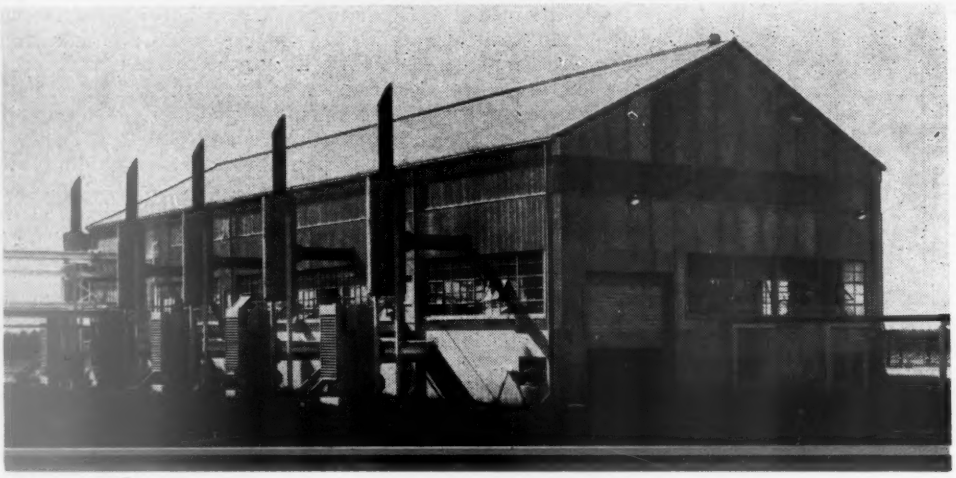
Warehouse, washroom, and garage, 110 ft long and 24 ft wide.

At each station five 2000-hp, 10-cylinder, 2-cycle compressors were installed.



Holiday detector being run over pipe on an East Texas spread.

Welding by electric arc method on Arkansas spread.



Main Compressor Building at Marshall, Texas, Station.

Texas Illinois Specified—

Steel Fabrication by Watkins

We consider it a distinct privilege to have been selected to fabricate and furnish the structural framing for the Compressor Rooms, Auxiliary Buildings, Warehouse and Garage Buildings, Warehouse and Welding Shop Buildings, Equipment Storage Buildings, Regulator and Meter Houses, Fire Houses and other miscellaneous structures at the five existing stations on the new Texas Illinois Natural Gas Pipeline Company system.

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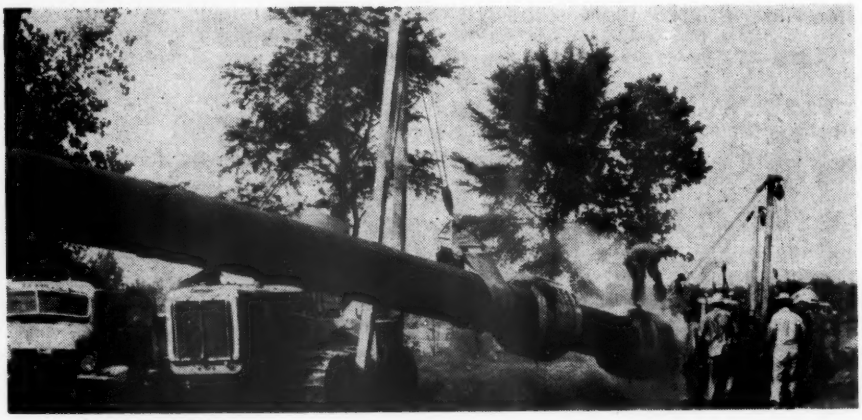
One of the many Edwards Concrete River Weights installations on Texas Illinois Natural Gas Pipeline.

Edwards Split Welding Sleeves also used on the line to insure perfect joints in swamps, rivers and safety zones.



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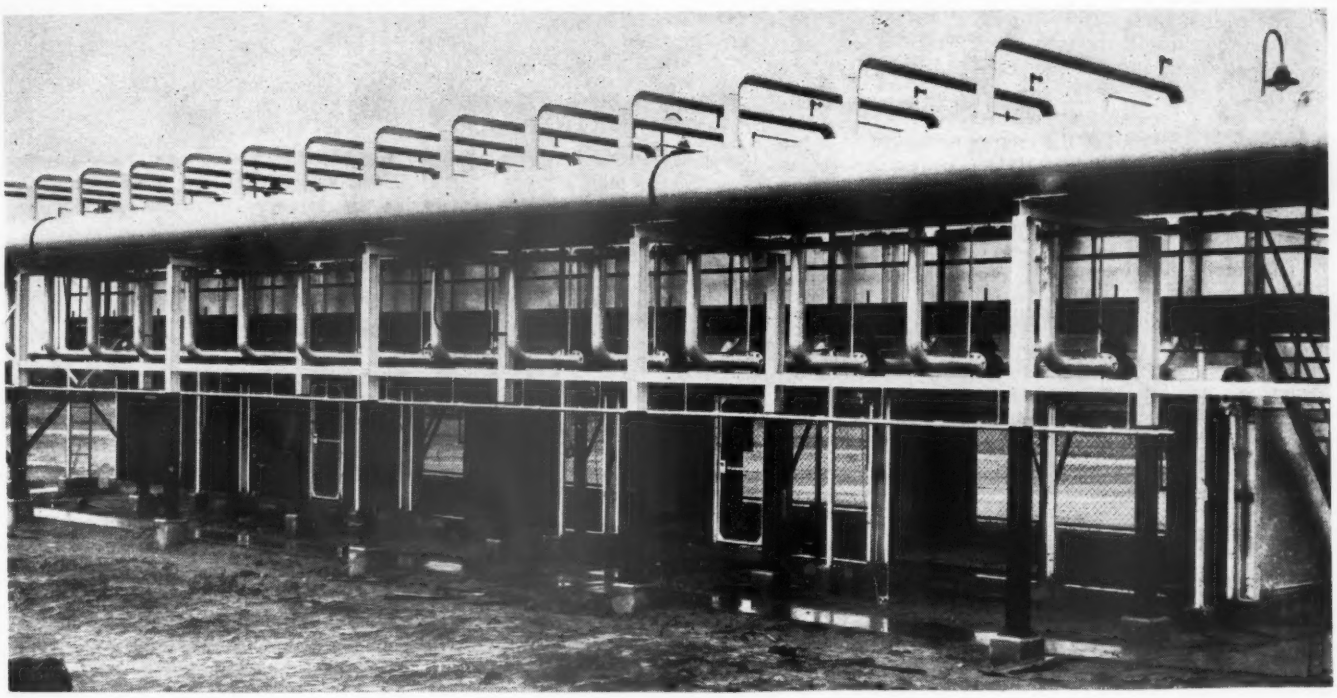
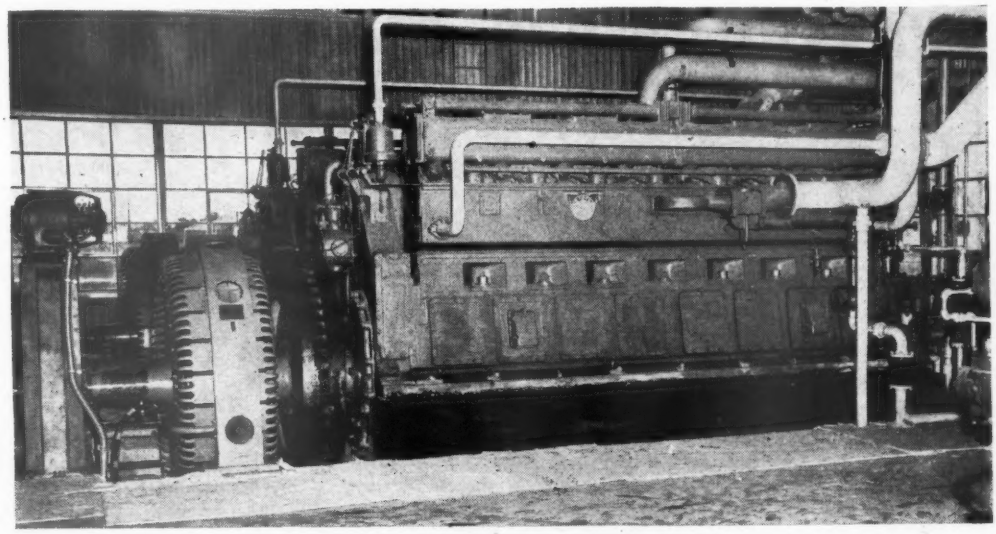
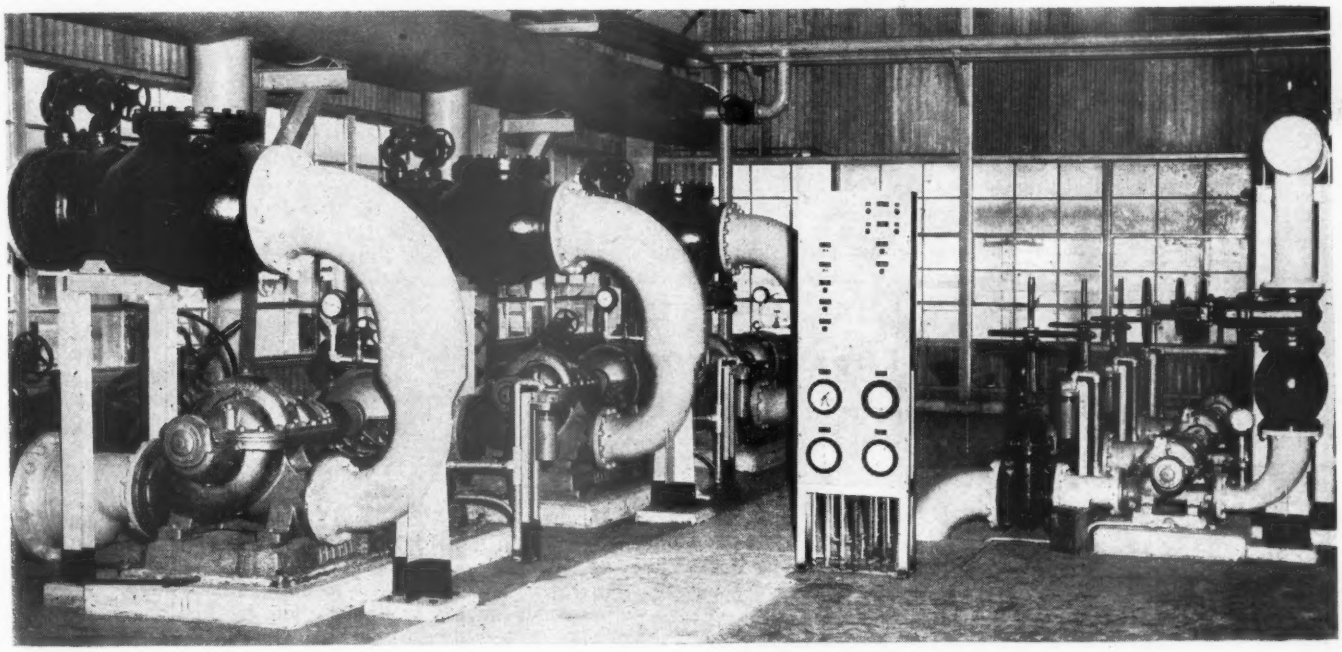


Fan type jacket water coolers.



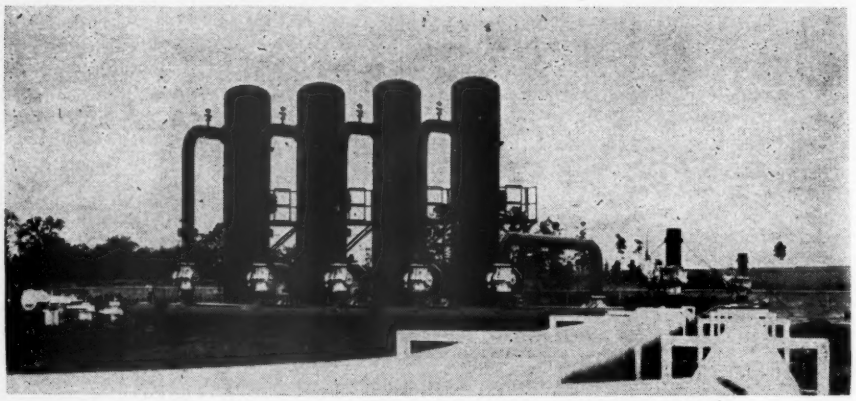
Two 610-hp gas engines driving 500-kva generators provide electric power at each station.

Jacket water pumps (left) and lube oil cooling water pumps (right).



The four dust scrubbers at each station are of the oilbath type, 60 in. OD by 22 ft 6 in. high. Dirty oil is discharged to two 54-in. OD by 6-ft settling tanks, where foreign matter is removed and the clean oil sent to the charge tank, the latter being a 30-in. OD by 18-ft horizontal vessel. The scrubber oil storage tank is 72-in. OD by 15-ft horizontal vessel.

The main regulating and metering station is at Joliet, Illinois. At this point the system of the Texas Illinois Natural Gas Pipeline Company and that of the Natural Gas Pipeline Company of America, an affiliate, meet. Gas from these two systems is measured separately before entering the Chicago District Pipeline Company system, which transports it to the city limits of Chicago for distribution by the Peoples Gas Light and Coke Company.



Dust scrubbers and suction and discharge lines.

Housing facilities for operating personnel are among the best provided on any pipe line system. A total of ninety-four 5-and 6-room houses have been constructed at the five stations, varying in number from 17 to 21 per station.

Communications

Long haul gas transmission lines require reliable communications for various operational functions, such as (1) pressure dispatching, (2) pipe line maintenance, (3) communication from the main office to various field offices, and (4) a means of fully utilizing FM radio installations in conjunction with the main communications system. In planning the Texas Illinois system, microwave radio relay, supplemented with FM base and mobile stations, was chosen as the best means of obtaining the necessary communications. In addition to the five compressor stations now in operation and the 6 that ultimately will be in use, communications are required to the meter and regulating station at Joliet, as well as to company offices in Chicago and Houston.

The survey to establish location of microwave stations along the route of the pipe line through the states of Illinois, Missouri, Arkansas, and Texas was begun on November 30, 1950, and completed March 30, 1951. The survey revealed the necessity for 26 intermediate repeater stations, situated between compressor stations and terminals, which would make a total of 40 stations on the system.

Details of the communications system are described in a separate article in this issue of *The Petroleum Engineer* written by Dale Samuelson of Motorola, Inc.

Contractors

The contractors for the principal construction work on the system are as follows:

Midwestern Constructors, Inc., 280 miles of 30-in. in Illinois and 100 miles of 26-in. in South Texas.

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H. C. Price Company, 300 miles of 30-in. in East Texas, 95 miles of 26-in. in South Texas, and 73 miles of 12 and 24-in. in the Gulf Coast area near Houston.

Bechtel Corporation, 408 miles of 30-in. in Arkansas and Missouri.

Western Pipe Line Constructors, Inc., 97 miles of 26-in., and 37.4 miles of 12-in. in South Texas.

Ray L. Smith and Sons, 55-mile, 20-in. lateral in Illinois between Joliet and Volo.

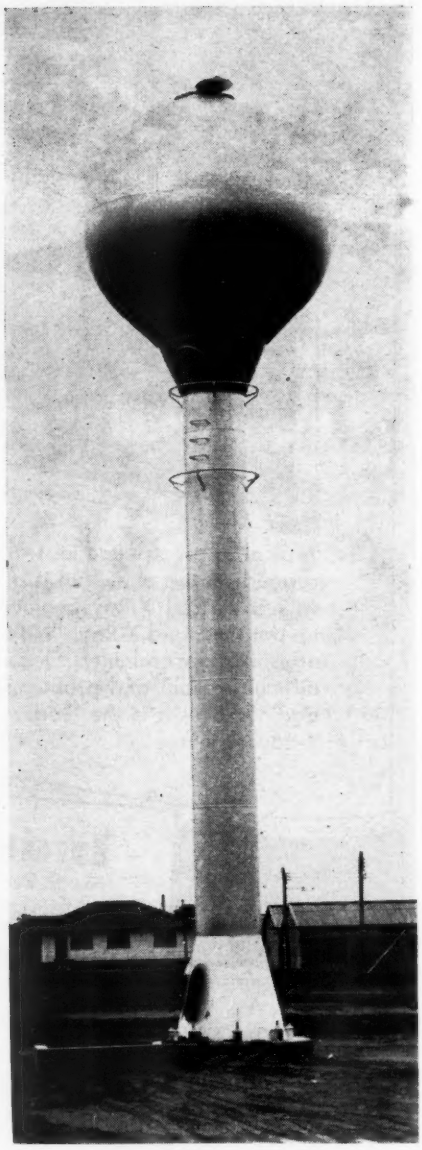
Parkhill Truck Company, and Dunn Brothers did the pipe stringing.

Generally, main line contractors also laid the river crossings on their sections. Exceptions were the suspension bridges. Wilder Kenan of Matthews and Kenan designed all suspension bridges. Pittsburgh-Des Moines Steel Company erected the Colorado and Brazos river bridges. Fisher Contracting Company installed the Red River bridge.

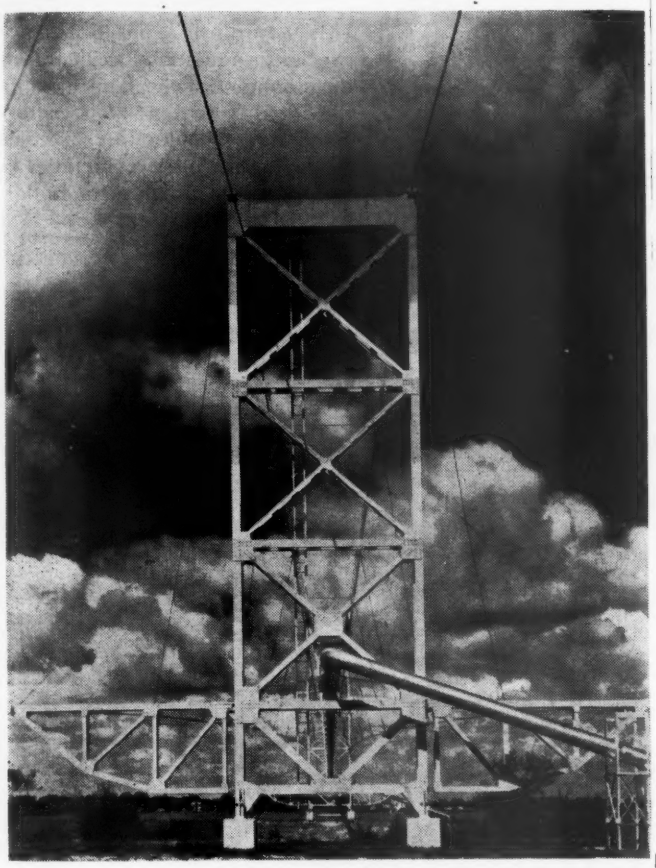
Fish Pipeline Construction Corporation designed and constructed the compressor stations, and performed certain other engineering functions, such as right-of-way procurement, survey work, drafting, damage settlement, etc.

Operating Personnel

The operating personnel of the Texas Illinois system are all experienced men. For construction purposes, certain key personnel were brought over from Natural Gas Pipeline Company of America. These men later were worked into the operating picture and additional men recruited from the same source to fill up the gaps.



Watersphere for domestic water supply.



COLORADO RIVER BRIDGE—*One of the bridges designed by Matthews & Kenan for the Texas Illinois Natural Gas Pipeline.*

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Acknowledgments

For the information contained in this article we are indebted to numerous persons connected with the Texas Illinois Natural Gas Pipeline Company, among them being: J. J. Hedrick, president; Mark V. Burlingame, vice president in charge of operations; R. G. Strong, chief engineer; M. J. Paul, chief design engineer; Warren T. Bulla, assistant superintendent of operations; O. E. Upson, superintendent of communications, and Keith Bentz, superintendent of pipe line construction. Also to M. T. Duddleston, chief engineer of the Fish Pipeline Construction Corporation.

To the H. C. Price Company and the Texas Illinois organization for certain of the photographs used as illustration.

* * *

DUNN Gets Stringin' DONE!

One of Dunn Bros.' big mobile cranes transferring pipe on the Texas-Illinois Natural Gas Pipeline in Central East Texas.

Dunn Bros.' Crews and Trucks stringing on the Tennessee Gas Transmission Line near Selmer, Tennessee.

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Microwave Communications

System is one of longest and most complete in the pipe line industry

DALE SAMUELSON*

Overlooking some of Chicago's tallest buildings is the north terminal of the Texas Illinois Natural Gas Pipeline Company microwave radio relay system. Radio frequency signals on which are superimposed telephone messages and other communications are transmitted and received directly from the Downers Grove repeater station.

ANOTHER major advance in pipe line communications was made when the new 1000-mile microwave radio relay system was officially opened for the Texas Illinois Natural Gas Pipeline Company.

From the installation of its first telegraph and telephone facilities adopted more than 20 years ago to fulfill the need for end-to-end pipe line communications control, Texas Illinois management has continually strived to improve its message facilities until it now boasts one of the longest and most complete communications systems in the pipe line industry.

The development of adequate communications facilities for Texas Illinois operation has paralleled closely, and at times led, the natural gas pipe line industry. In the earliest history of pipe line operations, competent communications were practically non-existent. Companies had to depend on messenger service, either by horseback or, in some cases, on foot.

Service by telephone companies was entirely inadequate, and in most cases, non-existent throughout the areas in which the pipe lines were being built and operated.

Private Pipe Line Communications

With the development of pipe line gathering systems and long product lines, messenger service and leased telephone communications were neither practical nor feasible, and the pipe line companies began to build their own privately owned overhead lines on their pipe line right-of-ways.

Twenty years ago communications for the Natural Gas Pipeline Company of America, a subsidiary along with the new Texas Illinois line of the Peoples Gas Light and Coke Company of Chicago, were a necessity between the Texas gas fields and Chicago just as they are needed today for the Texas Illinois system. At that time communications means of all types then available were considered, and telegraph and telephone were accepted as the most reliable and efficient.

These communications facilities were normally adequate for office-to-office message exchange but provided only limited services for exchanging information between company offices and repair crews and other employees along the pipe line route.

First Radio Systems

In the late 1930's some companies began using amplitude modulation (AM) radio systems for communications between district offices and pipe line crews. This means of communications was satisfactory in some cases but possessed all the limitations common to AM radio networks, of which one of the major disadvantages is static interference.

In looking back over the progress made in communications for producing a smoothly operating and efficient movement of gas or oil in pipe lines, Warren T. Bulla, assistant superintendent of operations of both the new Texas Illinois and the Natural Gas Pipeline systems, recalls that it was only 13 years ago that the first radio equipment was installed for the Natural Gas Pipeline Company. It consisted solely of one-way AM, low-frequency, emergency radio, the only type permissible at that time by the Federal Communications Commission, and actually just about the best equipment that could be manufactured at that time. Cars and trucks were equipped only with radio receivers.

Even with the limitations involved, pipe line company officials were quick to recognize the practical uses of radio in their industry and made plans to obtain recognition by the FCC to further the use of radio. In the early 1940's FM radio became available to industry in sufficient quantity to warrant experimental systems being installed in pipe line operations.

Pioneers in Radio

"We were one of the pioneers in the adopting of one-way radio equipment," Bulla reported. "This form of communications, along with the telephone, developed rapidly through the years. As the radio manufacturing industry improved base stations and mobile radio equipment this company accepted the most advanced developments, including the adoption of 2-way radio when it became available."

Bulla pointed out that no customer's service can be interrupted. In order to assure uninterrupted service it has been the practice of Texas Illinois management to adopt every modern tool to aid and assist in restoration of service for customers, enabling continuous delivery.

A long-haul natural gas pipe line system such as Texas Illinois employs a force of skilled dispatchers around the clock to maintain vigilance at all compressor stations, control points, and various building locations, and to maintain constant control of movement of gas by using modern communications facilities.

Selection of Microwave

Bulla said that a dispatching organization in the Chicago general office of Texas Illinois gives orders on the amount of gas to be turned in from the Texas wells, of the amount to be obtained from other suppliers, gives directions relative to engines that are to be operated and what pressures are to be carried, and in every way constantly reviews the operating conditions to ascertain that sufficient gas is moving to supply the requirements of the thousands of customers.

After considering the routing of the Texas Illinois line and the modern communications facilities possible, Bulla related, the company felt that some form of radio would give the Texas Illinois pipe line the best overall communications coverage of anything that was

*Communications and Electronics Division, Motorola, Inc.

EXCLUSIVE

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—You can save on operating manpower and supplies. Power plant control is automatic and self-protecting, with all the important auxiliaries shaft-driven from the main unit.

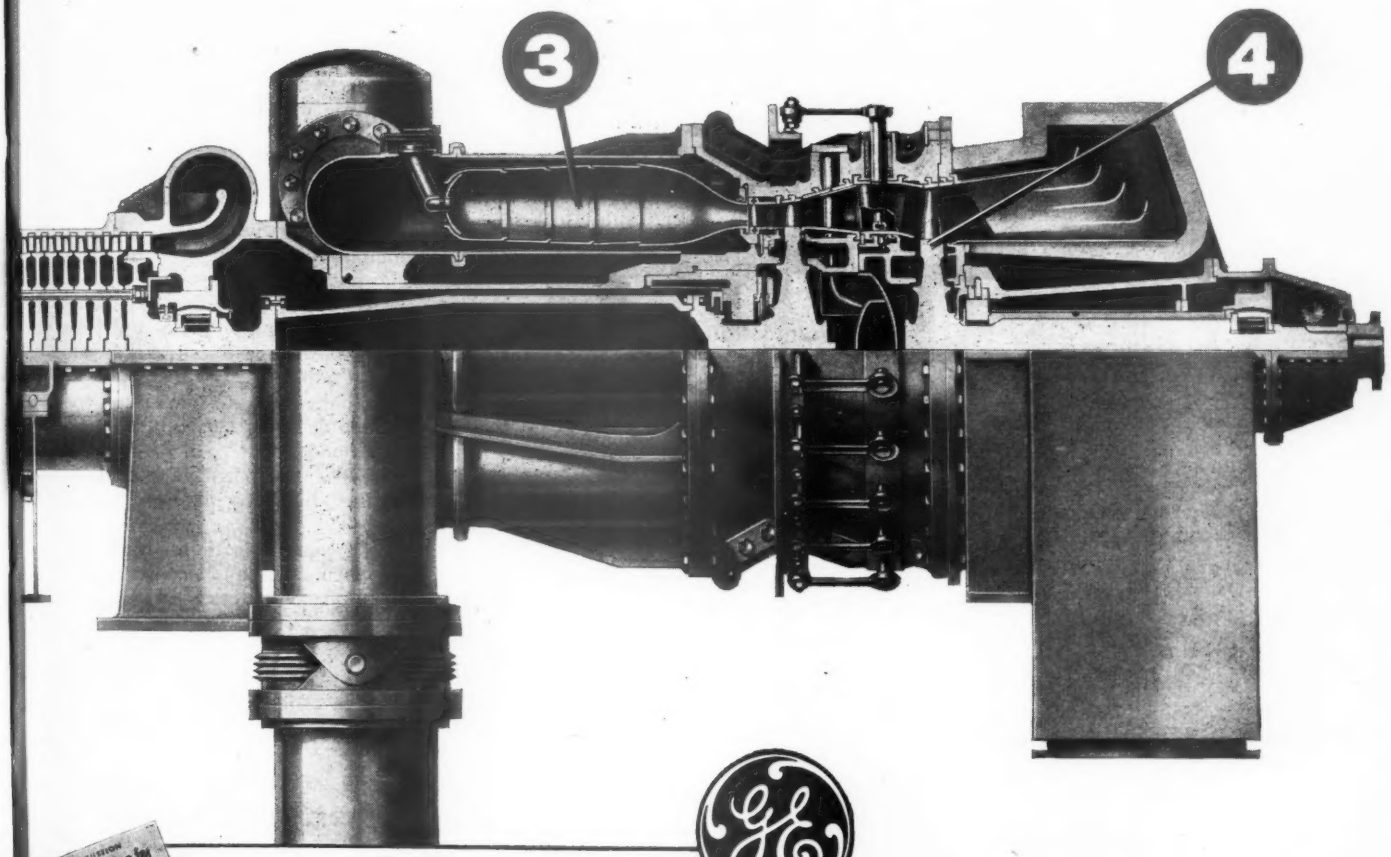
—You save on cooling water—an important point where water is scarce.

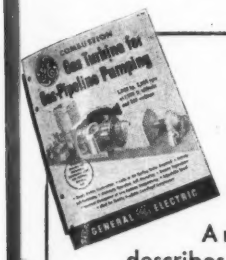
—You save on oil. A typical 5000-hp installation requires little or no make-up oil.

—You get adjustable speed for flexibility of operation to suit a variety of pipeline-flow conditions.

—You get up to 25 per cent extra hp in winter, when demand for gas is greatest.

Your G-E representative will gladly discuss this gas turbine in terms of *your* gas pipeline operation.





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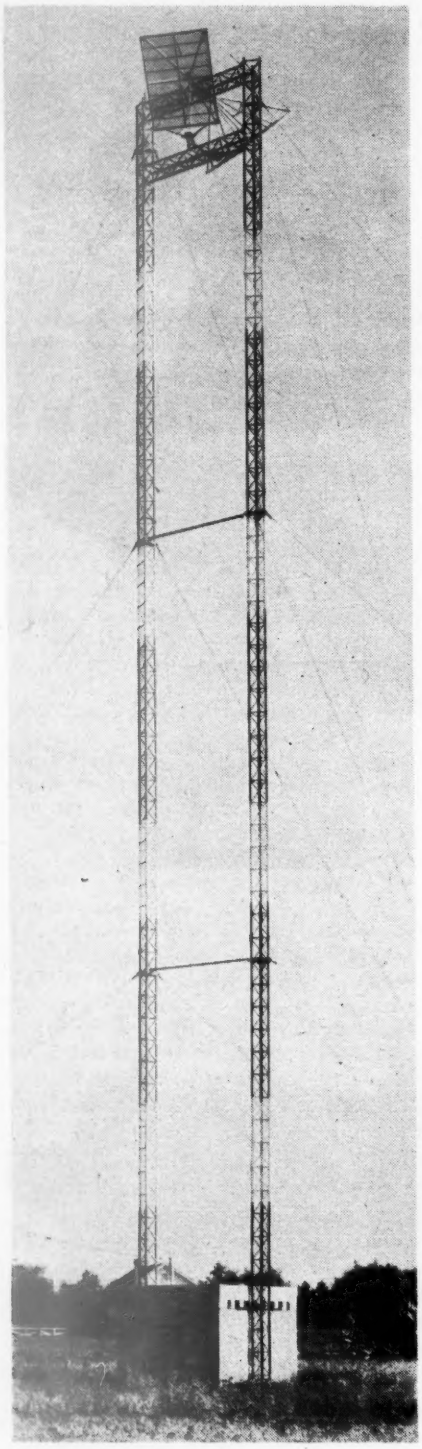
available. This conclusion was based, he said, on the fact that the pipe line system is routed over a number of hazardous areas, some of which are pestered by annual floods. He pointed out that the maintenance of telephone pole line would be extremely arduous at points where the line passes through timber areas where falling trees could create damage, and through other sections where the scarcity of useable roadways would produce difficulties when repair work would be required.

As a result of the tremendous developments in the 2-way radio communications field, which has made microwave radio relay available for pipe line companies, Texas Illinois contracted with Motorola Communications and Electronics Division for a microwave relay system and a complement of mobile 2-way radio equipment for cars and trucks as well as associated base station gear.



At Downers Grove, Illinois, the first repeater station outside Chicago rises above the surrounding trees and houses on the Texas Illinois Natural Gas Pipeline Company microwave radio relay system. This is a "straight-through" repeater station.

Microwave Theory

Microwave radio relay such as the Texas Illinois Natural Gas Pipeline Company is using is a method of transmitting simultaneously in both directions a number of communications signals superimposed on a high frequency carrier wave and relaying this intelligence from one point to another by the use of repeater stations. Because of the high frequency used—the Texas Illinois system frequency range is between 6575-6875 megacycles — these carrier waves act much like a beam of light that can be directed, reflected, diffracted, and refracted. Instead of the signal being transmitted in all horizontal directions, as it generally is by inland radio broadcast stations, the signal can be focused into a beam with a 3½ deg inside angle as used on the Texas Illinois system. It can then be directed toward the receiving point without the waste of radio frequency energy that might otherwise be scattered in all directions.

Relaying these beams of radio energy from one point to another results in the formation of a point-to-point radio communications network called a microwave radio relay system.

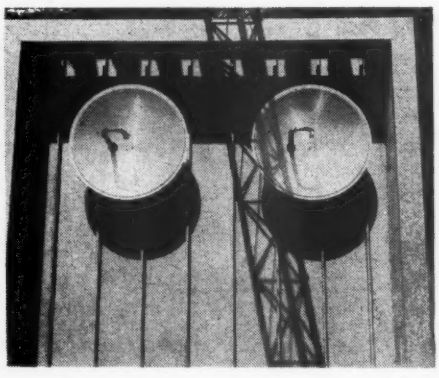
Communications Available

The Texas Illinois microwave radio relay system follows closely the path of the pipe line, extending from Hungerford, Texas, near Houston, up through Texarkana, past Little Rock, Arkansas, across the southeastern corner of Missouri, and across Illinois, through Joliet to Chicago.

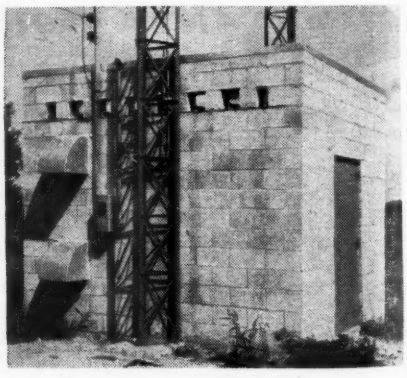
Onto the carrier wave of this Motorola microwave system built for the Texas Illinois Company are superimposed the following communications facilities:

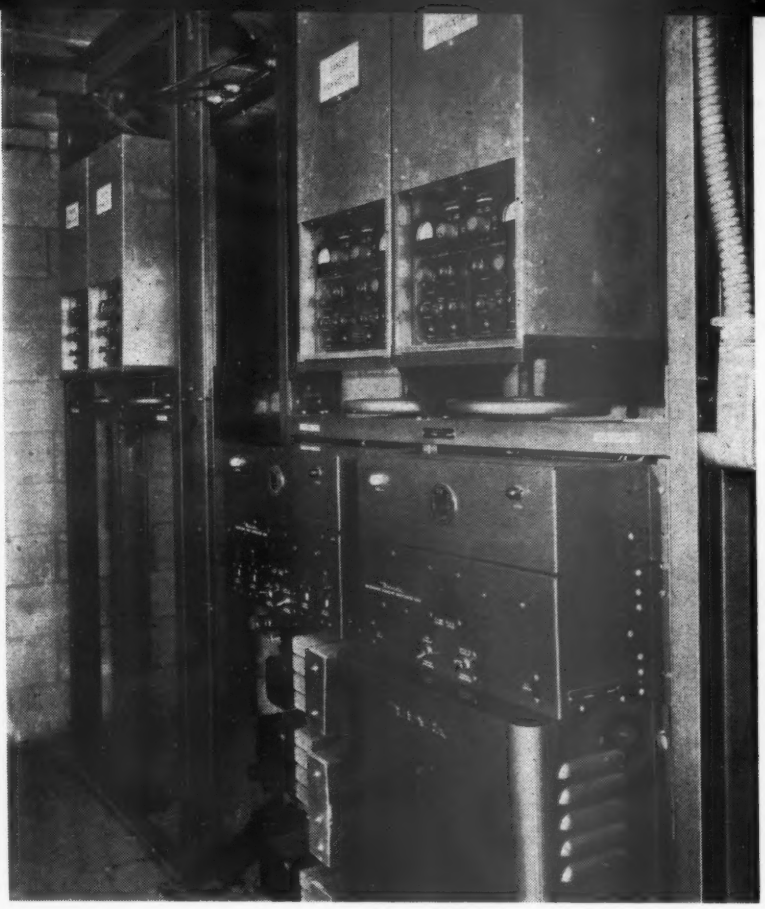
1. A dispatchers party line, or pressure circuit, with selective dialing, for voice communications between any of the terminals or microwave relay installations at all Texas Illinois pump stations. This communications facility is available at each of the following stations:
   a. Chicago terminal
   b. Hammond, Illinois, repeater.
   c. Hoffman, Illinois, repeater.
   d. Marble Hill, Missouri, repeater.
   e. Biggers, Arkansas, repeater.
   f. Searcy, Arkansas, repeater.
   g. Malvern, Arkansas, repeater.
   h. Texarkana, Arkansas, repeater.
   i. Marshall, Texas, repeater.
   j. Lufkin, Texas, repeater.
   k. New Caney, Texas, repeater.
   l. Hungerford, Texas, repeater.
2. A maintenance party line, or pipe line circuit, with selective dialing, for voice communications between the same points that have pressure circuit facilities as listed above.
3. An executive private line circuit for voice communications between the Chicago offices and the offices in Houston.
4. An executive private line circuit for voice communications between the Chicago offices and the Malvern, Arkansas, pumping station.
5. An executive private line circuit for voice communications between the Chicago offices and Joliet.
6. A private line circuit for voice communications between Houston and Hungerford.
7. A VHF communications circuit for carrying voice communications signals between any Texas Illinois radio-equipped car or truck along the pipe line system to any other such car or truck anywhere along the 1000-mile microwave relay system, or between any of the pumping stations and a Texas Illinois

Looking down from the tower above the roof of the Downers Grove station. The radio frequency signals are transmitted and received via the parabolic antennas and the passive reflectors atop the tower.



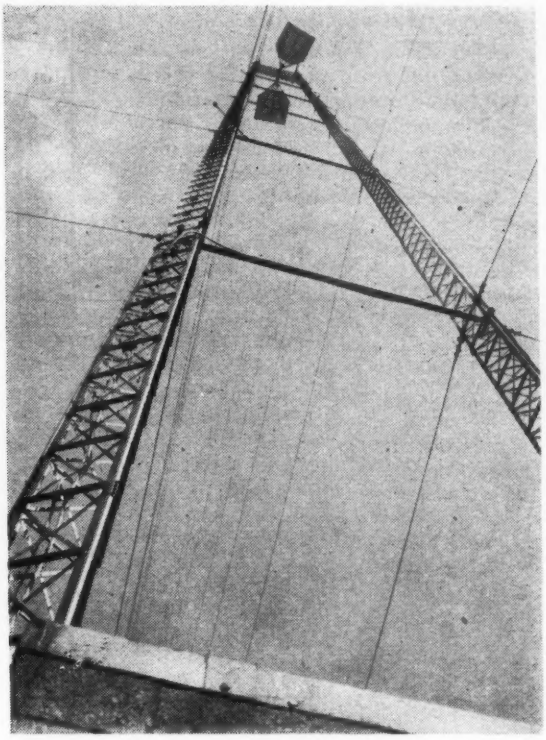
Close-up of the concrete block house at Cabery, Illinois. At the left are seen the oil intake vents. By building everything within the housing all equipment is completely weatherproof.



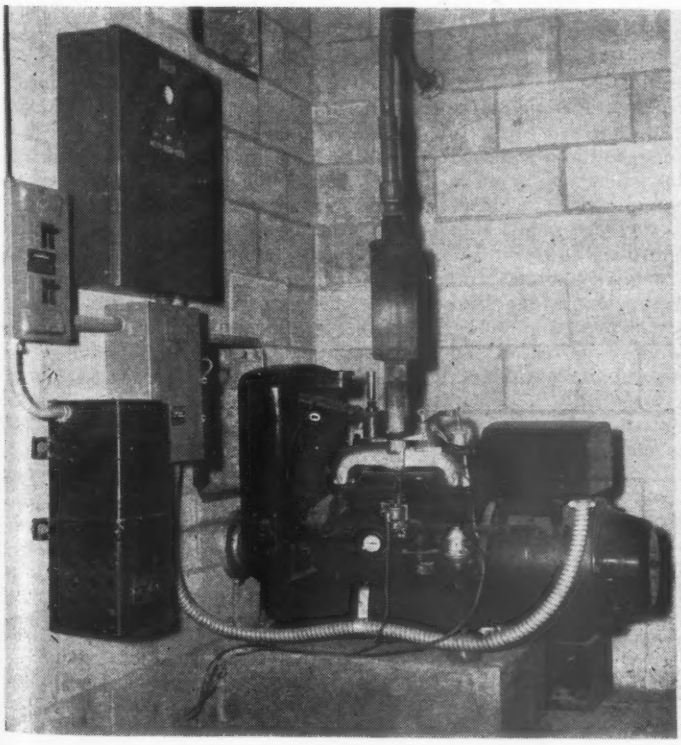


Radio equipment installed at the Downers Grove repeater station. Mounted in these racks are the radio frequency, control, and power supply equipment; complete standby installations for each.

Looking up the 300-ft twin-tower at Joilet, Illinois. At the very top is mounted the VHF antenna for 2-way communications between any radio-equipped Texas Illinois car or truck in the area and any dropout repeater station or other vehicle along the pipe line.



At the Downers Grove station is installed this standby gasoline driven power supply. Should normal power supply facilities fail at any time this unit would automatically and immediately begin functioning to furnish power needed for operation of the repeater station.



In the Joliet repeater station concrete block house can be seen the VHF mobile radio equipment cabinet at the left. The cabinet at the right contains microwave sub-carrier equipment. In the back of the room can be seen part of the standby power supply.

radio-equipped car or truck wherever it might be along, or within reasonable range of, the system right-of-way.

8. Other circuits used for alarm signals and for microwave maintenance personnel communications.

System Design

Thirty-seven repeater stations are necessary to create an unbroken carrier wave radio beam between the terminals in Chicago and Hungerford. Each of these microwave repeater stations picks up the carrier wave signals from the stations nearest it—one being on each side of it some 25 or so miles away—reamplifies these signals and transmits them to the stations on the other sides.

For instance, a repeater station on the Texas Illinois line receives the carrier wave signal from the station just north of it, reamplifies this signal and transmits it on to the next repeater station to the south. Simultaneously it is receiving the signal from the station to the south, reamplifying it and sending it on to the station to the north.

All microwave communications facilities available to Texas Illinois can be in use simultaneously as a result of this carrier wave radio beam that extends from one end of the system to the other and is being relayed by the repeater stations.

Equipment Design

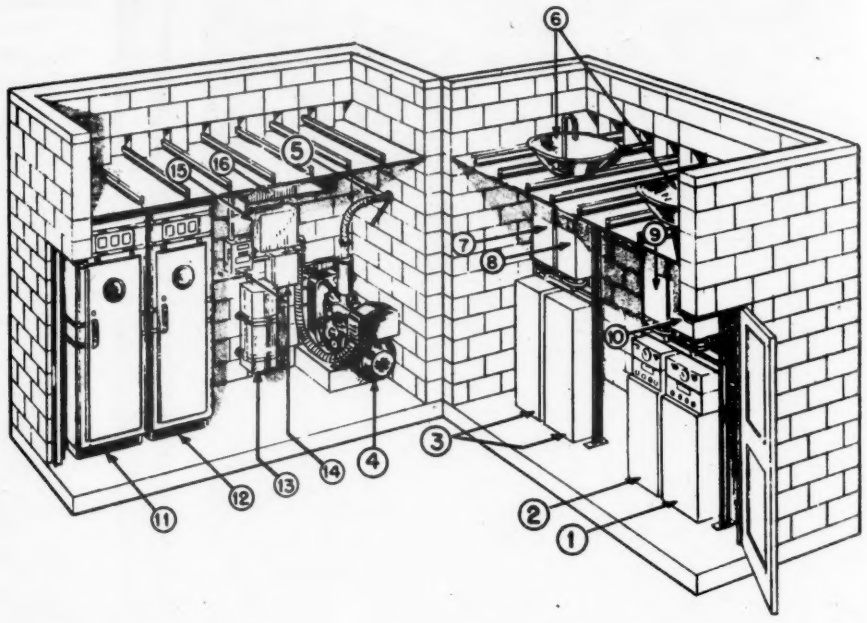
The repeater stations on the system are of the Motorola design that makes it possible to have all radio equipment installed on the ground where it is readily accessible for checking and servicing. The radio installation at each station is completely enclosed in a concrete block house. Two 40-in. paraboloid reflector-antennas are mounted on the building's roof directly above the radio frequency equipment. Each antenna simultaneously transmits and receives.

The paraboloid antenna projects the microwave radio beam to a flat passive reflector above it at the top of a tower, at which point the beam is re-directed horizontally toward the next relay station. Once the carrier wave beam hits a passive reflector in its path it is cast downward to the paraboloid antenna beneath. This process continues until the carrier wave, and the signals impressed on it, arrive at a terminal point or the desired intermediate station.

The Texas Illinois microwave radio relay system incorporates the recently engineered and improved Motorola Micropackage design in which all the necessary radio equipment is installed in two racks completely built inside the concrete block house—one beneath each of the antennas mounted on the roof. Installed in each rack is the RF equipment, control equipment, and power supplies.

Repeater Types

Two types of repeater stations are installed along the Texas Illinois system. These are:



This drawing shows the microwave radio equipment installed in a typical concrete block "drop-out" repeater along the Texas Illinois pipe line. Equipment indicated is as follows:

1. Standby control and RF power supply equipment.
2. Main control and RF power supply equipment.
3. Auxiliary rack space.
4. Emergency gasoline engine driven power supply.
5. Wall exhaust for emergency power unit.
6. 40-in. Paraboloid antennas.
7. Main RF unit (one direction).
8. Standby RF unit (one direction).
9. Main RF unit (other direction).
10. Standby RF unit (other direction).
11. VHF mobile radio equipment cabinet.
12. Radio equipment cabinet for "drop-out" facilities.
13. Voltage regulator.
14. Load center.
15. Emergency power transfer unit.
16. Tower light controls.

1. "Straight-through" repeaters.
2. "Drop-out" repeaters.

Straight-through repeaters are those that have only equipment for receiving, amplifying, and retransmitting the carrier wave radio beam. These stations, of which there are 26, are completely unattended and operate only as facilities for extending the communications range between pumping stations.

Drop-out repeaters are those installed at pumping stations where one or more of the various communications facilities are available. It is at these points that the carrier wave is broken down into its components, or sub-carrier circuit frequencies, to make message facilities available through a dispatching center, and are then re-superimposed on the carrier wave for transmission to the next station.

The compressor stations at these drop-out repeaters incorporate an extensive telephone termination system, which includes line terminal units, multi-line telephones, and 20-cycle ringing generators.

Terminal Stations

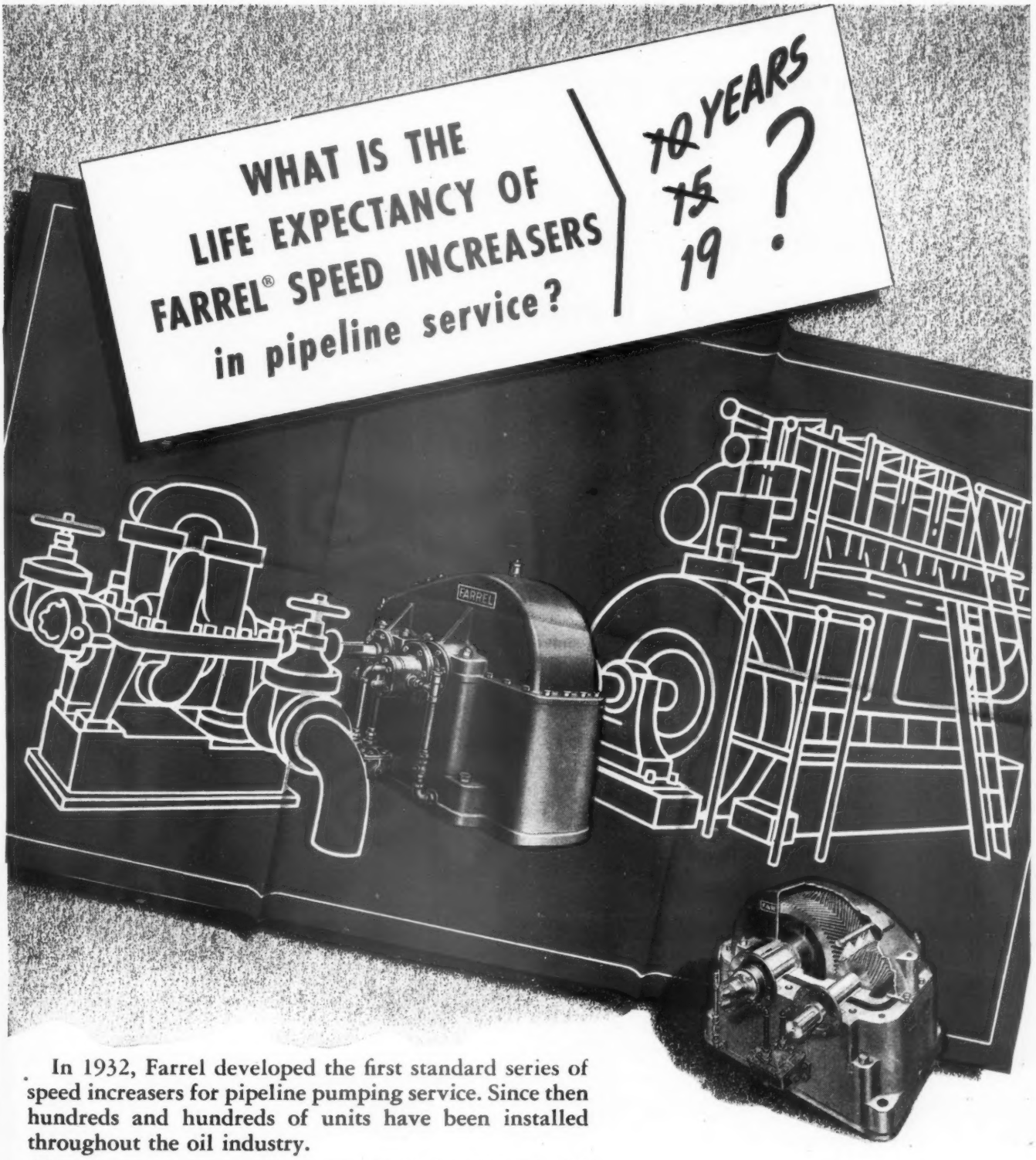
A microwave relay spur connects the Houston terminal to the main microwave system at North Houston, the second repeater station on the system north of Hungerford.

The receiving and transmitting equipment at Houston is installed on the 16th floor of the Texas Avenue Building.

The Chicago terminal for the Texas Illinois microwave relay system is on the 40th floor atop the Civic Opera Building in the downtown area. Because of the height of the terminals at both Chicago and Houston, no tower construction was necessary and the radio equipment is roof-mounted in weatherproof housings.

A paraboloid antenna at each of the terminals in Chicago and Houston is mounted above the radio equipment but instead of being installed horizontally as are the antennas at repeater stations, it is installed vertically with the face of each dish pointing directly at the closest repeater station along the pipe line route. The Chicago antenna points at the Downers Grove, Illinois repeater station and the Houston antenna faces the North Houston repeater station.

In the Texas Illinois Chicago offices is installed all the voice communications terminal equipment necessary for dispatching and receiving information to and from the various points along the system. All microwave circuits at both Chicago and Houston terminate at an office PABX telephone board at which point any incoming calls over the microwave system can be switched to any office.



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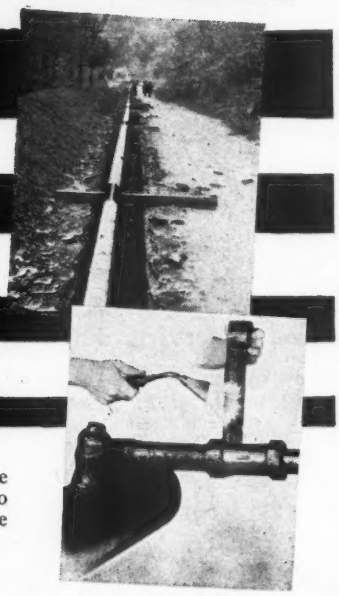

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Standby Protection

Although each of the hundreds of tubes in the system have a life expectancy of 20,000 hours or more, it is important that facilities are available for preventing the loss of communications when one of these tubes, or other functioning part, fails. For this purpose complete standby equipment including separate cables and power supplies are built into the network. Each of the Micropackage racks is constructed to include two complete transmitter-receiver units, one for normal operation, one for emergencies. Sensing circuits built into the equipment can recognize a failure of any tube or component and automatically switch over to the standby gear with only a few seconds interruption to communications.

Normally, power is supplied to each repeater station from public utility lines. In case of loss of this power at a repeater site a standby gasoline-driven generator has been installed that immediately begins operation to provide power for continued functioning of the microwave radio equipment.

Mobile Communications

Texas Illinois management at the present time has 41 2-way radio-equipped cars and trucks in operation along the Natural Gas and the Texas Illinois systems for use by maintenance crews, supervisors, and other operating personnel. Another 80 are in the process of being delivered from Motorola as part of the microwave system contract.

The Texas Illinois VHF mobile communications are tied in with similar communications facilities along the Natural Gas Company pipe line by a junction of the two systems at Joliet, Illinois, meter station, making it possible to maintain communications between points on each of the two pipe lines.

Expansion Possibilities

The Texas Illinois Natural Gas Pipeline Company microwave relay system is so designed that the company can, at any time, add other electronic circuits. By the addition of these circuits, the position of all switches, signals, and valves, and the readings of all important meters can be displayed at any or all dispatch points. The remotely controlled system will be able, then, to provide for adjustment and operation of any number of these valves, switches, or other unattended devices by activating the proper circuits.

Spare channel facilities also are available for expanding the number of voice communications circuits as desired by the company.

Chester E. Upson, superintendent of communications for the company, has charge of maintaining a message exchange facility that is efficient, adequate, and reliable. He and his company will enjoy a communications network that will fulfill all the requirements for controlling the movement of gas from the fields of southern Texas to the thousands of gas users in the Chicago area. * *

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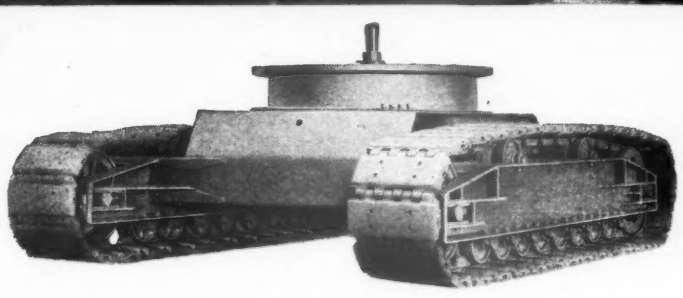

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PIPE LINE STATISTICS

Income, operating expenses, expenditures for new construction, property investments, and other data given in the ICC report

THE annual report of the Interstate Commerce Commission, giving statistics on crude oil pipe lines, including 1950, reveal that construction expenses during 1950 were greater than in 1949, operating expenses were higher, income was up, taxes showed a considerable increase, and, of course, the number of miles of pipe line in operation was greater.

The total mileage as of the beginning of 1951 was 80,996 miles as compared with 77,772 miles in 1949, an increase of 3224 miles. There were 64,622 miles of crude trunk lines in operation, an increase over the previous year of 983 miles; 16,374 miles of products lines, a gain of 2241 miles, and 47,593 miles of gathering lines, an increase of 381 miles. It can be seen, therefore, that the principal construction in this field was of products pipe lines.

Total investment in carrier property by pipe line companies at the start of 1951 was $1,655,972,861 compared with $1,497,578,989 in 1949, an increase of $158,393,872. Of these totals, $1,388,473,631 were invested in trunk lines in 1950 compared with $1,237,715,588 in 1949; $206,423,747 for gathering lines as against $195,693,171, and $61,075,483 for general property compared with $64,170,230 the previous year. This gives an increase in trunk line investment of $140,758,043, an increase in gathering line investment of $10,730,576, and a decrease in general property investment of $3,094,747.

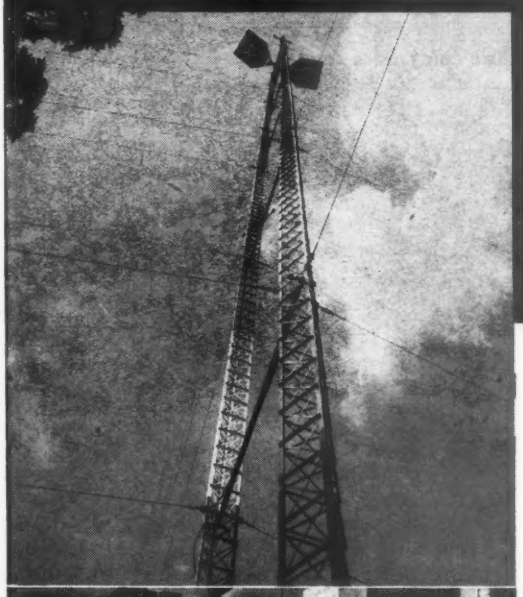
Expenditures for new construction and improvements totaled $200,922,596, of which $182,886,890 was for trunk lines, $20,046,285 for gathering lines, and a deficit of $2,010,579 for general property. Thus, expenditures for these purposes exceeded the previous year by $44,262,915. Construction work in progress amounted to $5,254,381.

Operating revenues showed an increase of $65,175,165 compared with 1949; 1950 revenues totaled $441,627,281 compared with $376,452,116 the year before. In comparison with 1944, the earliest figures given by ICC in accompanying tables, revenues were up $131,432,828. On the other hand, op-

TABLE 1. Income and earned surplus accounts of pipe line companies.

Item	1950	1949
Income Statement		
Operating Income		
Operating revenues	$348,905,244	$293,981,390
Operating expenses	193,547,605	189,224,789
Net revenue from operations	155,357,639	104,756,601
Pipe line taxes:		
Income and excess-profits taxes	54,249,200	28,883,155
Other taxes	26,522,346	23,504,328
Total pipe line taxes	80,771,546	52,387,483
Pipe line operating income	74,586,093	52,369,118
Income from miscellaneous operating physical property	22,481	.....
Taxes on miscellaneous operating physical property	425	.....
Miscellaneous operating income	22,056	.....
Total operating income	74,608,149	52,369,118
Other Income		
Income from miscellaneous nonoperating physical property	30,218	28,315
Dividend income	253,127	391,274
Interest income	1,372,255	1,273,888
Income from insurance and other reserve funds	24,159	24,738
Release of premium on funded debt	.....	.....
Miscellaneous income	215,788	383,361
Delayed income credits	117,920	.....
Total other income	2,013,467	2,101,576
Total income	76,621,616	54,470,694
Miscellaneous Deductions From Total Income		
Miscellaneous taxes	$121,144	$107,829
Miscellaneous income charges	166,227	266,945
Bad debts	1,025	10,567
Delayed income debits	.....	.....
Total miscellaneous deductions	288,396	385,341
Income available for fixed charges	73,333,220	54,085,353
Fixed Charges		
Interest on long-term debt	8,583,062	6,038,744
Interest on unfunded debt	555,263	516,263
Amortization of discount on funded debt	73,136	32,131
Total fixed charges	9,211,461	6,587,138
Income after fixed charges	67,121,759	47,498,215
Contingent Charges		
Contingent interest on debt	.....	.....
Net income	67,121,759	47,498,215
Disposition Of Net Income		
Miscellaneous reservations of income	$31,057	$2,204,872
Stock discount extinguished through income	.....	.....
Dividend appropriations of income	27,847,544	14,597,945
Total appropriations of income	27,878,601	16,802,817
Income balance	39,243,158	30,695,398
Earned Surplus Statement		
Earned surplus at beginning of year	109,131,207	99,111,019
Income balance	39,243,158	30,695,398
Credits from retired carrier property	1,080,510	85,642
Miscellaneous credits	2,262,125	596,599
Debits from retired carrier property	89,119	8,583
Miscellaneous debits	159,452	254,464
Miscellaneous reservations of surplus	8,596,388	9,021,288
Stock discount extinguished through surplus	.....	.....
Dividend appropriations of surplus	23,387,951	12,073,710
Earned surplus at end of year	119,475,090	109,130,613

21—Motorola microwave systems are in and working!



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- State of California
- Pan American Pipeline Co.
- Shell Pipeline
- Panhandle Eastern Pipeline Co.
- Texas Illinois Natural Gas Pipeline Co.
- Mid-Valley Pipeline Co.
- Brazos River Electric Transmission Cooperative
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erating expenses showed a considerable advance. For 1950 they were $254,701,469; for 1949, $249,368,200, and for 1944, $172,367,510, an increase in 1950 of $5,033,269 over 1949, and of $82,333,959 over 1944.

Taxes showed a considerable advance, going from $63,801,677 in 1949 to $97,878,477 in 1950, an increase of $34,076,800. Of this amount, the United States government was paid $82,464,111, and others $15,414,366.

Net income of pipe lines was $81,303,156 in 1950 compared with $57,743,412 in 1949 and $65,715,492 in 1944.

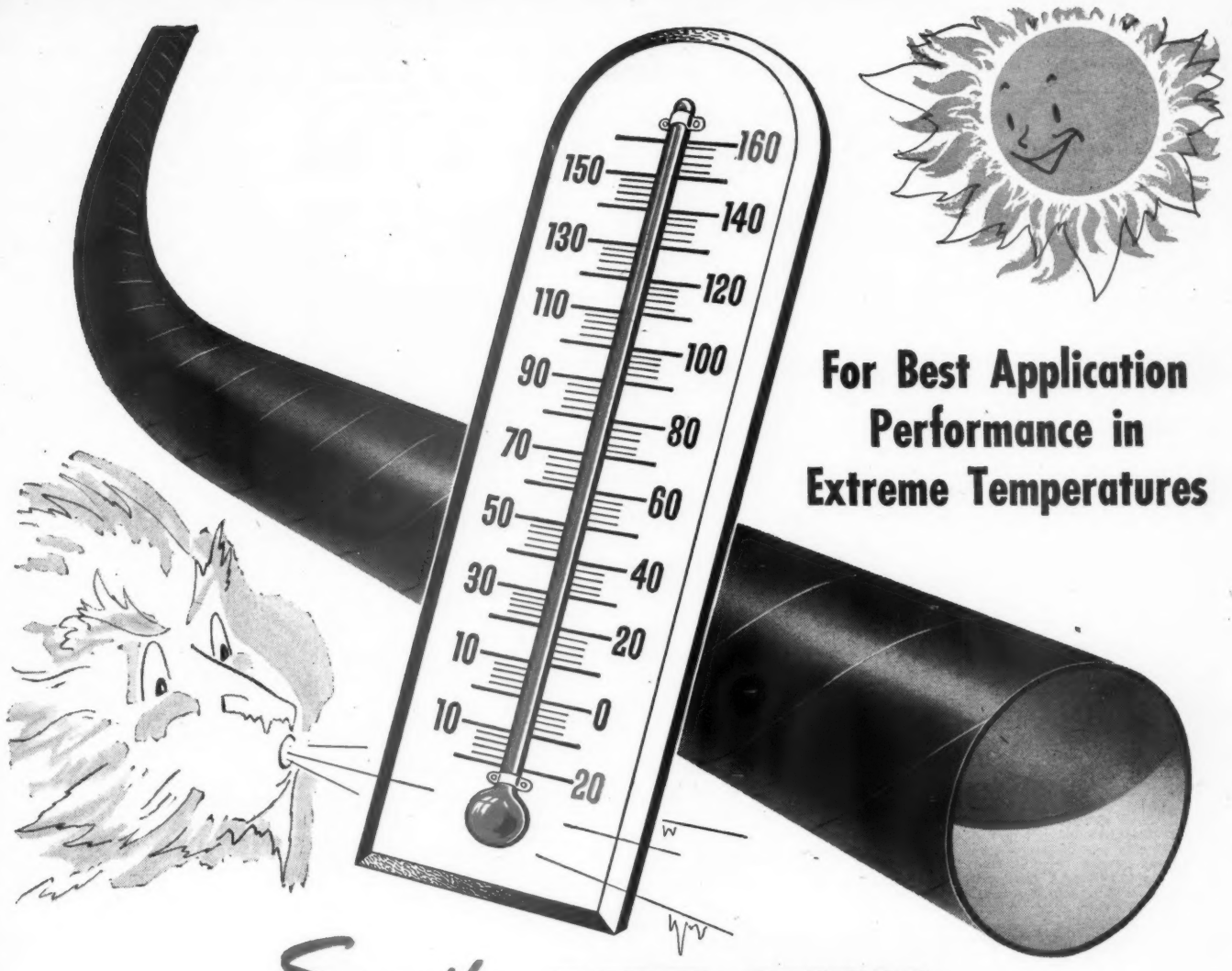
Dividend appropriations from current income and earned surplus totaled $51,235,495 for 1950, $26,671,655 for 1949, and $22,018,752 for 1944.

Depreciation charged to operating expenses was as follows: Trunk lines, $46,878,826 in 1950 and $42,808,274 in 1949; gathering lines, $9,817,984 in 1950 and $9,304,963 in 1949. The totals are $56,696,810 for 1950 and $52,113,237 for 1949.

This summary and abstract of statistics for the calendar year 1950 is the 32nd in a series compiled by the Interstate Commerce Commission from an-

TABLE 2. Summary of selected financial and operating data of pipe line companies for the years 1944-1950.

Item	1950	1949	1948	1947	1946	1945	1944
Number of companies at close of year	76	73	73	71	70	74	75
Mileage Operated							
Gathering lines	47,593	47,212	47,036	45,909	44,862	43,994	43,276
Trunk lines	80,996	77,772	77,056	73,389	71,682	69,357	68,339
Balance-Sheet Items							
Investment in carrier property	$1,655,972,861	$1,497,578,988	$1,381,402,464	$1,225,168,434	$1,106,453,978	$1,042,522,828	$1,000,741,256
Other investments	100,798,172	78,285,034	52,167,727	56,454,869	69,990,898	86,713,055	62,766,589
Cash	64,590,519	45,381,191	45,159,043	44,193,933	39,033,755	40,612,464	36,594,207
Material and supplies	33,847,764	38,109,334	41,382,948	32,509,860	23,370,998	21,004,827	18,912,057
Total current assets	192,290,986	175,458,317	168,020,450	126,621,264	103,818,665	115,369,824	104,149,919
Capital stock	236,078,523	235,699,492	235,376,467	233,815,067	240,148,818	253,782,318	243,377,123
Funded debt unmatured	424,237,743	312,953,715	203,806,644	105,543,388	57,659,257	47,430,525	39,250,628
Total current liabilities	126,277,610	97,377,436	110,130,735	105,067,279	82,789,274	77,642,008	90,962,445
Accrued depreciation-carrier property	655,205,545	623,709,410	599,893,353	573,519,643	550,765,295	527,617,747	500,534,311
Amortization reserve	69,785,479	73,051,421	73,754,252	73,603,508	71,510,994	64,721,525	48,695,296
Total surplus	218,794,823	201,569,557	180,055,599	147,836,483	129,195,116	120,251,448	93,016,189
Income Items							
Operating revenues	441,627,281	376,452,116	377,034,023	325,223,884	293,722,598	304,268,132	310,194,453
Operating expenses	254,701,469	249,368,200	252,970,772	214,681,999	183,869,101	191,667,755	172,367,510
Pipe-line taxes:							
United States Government taxes	82,464,111	49,074,907	52,453,499	44,369,699	43,292,770	35,729,646	60,794,752
Other than United States Government taxes	15,414,366	14,726,770	12,804,107	11,757,038	10,075,527	9,743,325	9,192,475
Total	97,878,477	63,801,677	65,257,606	56,126,737	53,368,297	45,472,971	69,987,227
Pipe line operating income	89,047,335	63,282,239	58,805,645	54,415,148	56,485,200	67,127,406	67,839,716
Interest on long-term debt	9,012,285	6,674,285	4,057,922	2,540,335	2,349,920	2,269,076	2,475,683
Net income	81,303,156	57,743,412	56,679,058	53,144,549	56,094,398	65,940,663	65,715,492
Dividend appropriations:							
From current income	27,847,544	14,597,945	13,644,377	9,462,899	14,999,189	14,991,137	17,513,853
From earned surplus	23,387,951	12,073,710	8,015,555	14,179,692	20,341,903	3,689,885	4,504,899
Total	51,235,495	26,671,655	21,659,932	23,642,591	35,341,092	18,681,022	22,018,752
Depreciation charged to operating expenses:							
Gathering lines	9,817,984	9,304,963	8,600,620	8,025,724	7,365,571	7,273,276	6,609,519
Trunk lines	46,878,826	42,808,274	37,873,160	34,452,758	32,820,881	44,350,642	35,377,354
Total	56,696,810	52,113,237	46,473,780	42,478,482	40,186,452	51,623,918	41,986,873
Statistics							
Oil transported:							
Numbers of barrels received into system:							
From connecting carriers:							
Crude oil	879,068,095	748,617,579	851,446,666	804,894,032	735,137,031	859,318,798	880,451,009
Refined oils	65,154,606	57,174,436	54,283,464	58,962,357	64,204,253	78,035,465	93,471,000
Total	944,222,701	805,792,015	905,730,130	863,856,389	799,341,284	937,354,263	973,922,009
Originated:							
Crude oil	1,524,932,315	1,414,886,575	1,586,331,016	1,431,191,245	1,318,766,572	1,291,922,201	1,277,197,360
Refined oils	297,254,686	240,850,328	227,480,846	186,812,885	154,118,079	149,967,062	146,967,426
Total	1,822,187,001	1,655,736,903	1,813,811,862	1,618,004,130	1,472,884,651	1,441,889,263	1,424,164,786
Total received into system	2,766,409,702	2,461,528,918	2,719,541,992	2,481,860,519	2,272,225,935	2,379,243,526	2,398,086,795
Oil transported:							
Number of barrels delivered out of system:							
To connecting carriers:							
Crude oil	874,097,185	740,202,729	829,232,167	793,746,765	715,351,965	894,147,153	959,614,186
Refined oils	63,185,220	51,925,633	51,175,291	57,119,394	50,892,070	70,322,532	83,049,031
Total	937,282,405	792,128,362	880,407,458	850,866,159	766,244,035	964,469,685	1,042,663,217
Terminated:							
Crude oil	1,509,663,726	1,405,325,716	1,589,730,078	1,435,565,648	1,327,402,432	1,243,601,027	1,190,321,412
Refined oils	293,326,335	250,488,816	227,001,314	187,907,938	166,626,213	157,335,016	156,368,821
Total	1,802,990,061	1,655,814,532	1,816,731,392	1,623,473,586	1,494,028,645	1,400,936,043	1,346,690,233
Total delivered out of system	2,740,272,466	2,477,942,894	2,697,138,850	2,474,339,745	2,260,272,680	2,365,405,728	2,389,353,450
Number of barrels having trunk-line movement:							
Crude oil	1,976,569,928	1,753,996,239	1,947,066,490	1,797,969,737	1,664,599,595	1,721,440,553	1,749,577,159
Refined oils	360,276,465	302,588,264	280,019,453	245,161,310	217,472,898	228,226,175	251,399,847
Number of barrel-miles (trunk-lines):							
Crude oil (thousands)	577,054,200	497,178,743	513,497,782	465,503,961	428,843,173	429,942,740	437,679,901
Refined oils (thousands)	106,648,715	92,562,756	85,087,129	71,554,783	58,752,072	65,360,294	70,916,543
Employees							
Employees and their compensation:							
General officers and general office employees:							
Average number	3,067	2,968	2,870	2,740	2,535	2,330	2,228
Compensation	$15,282,175	$14,100,317	$13,177,806	$11,438,245	$9,546,582	$8,308,112	$7,861,332
All other employees:							
Average number	23,155	24,418	25,693	24,345	23,272	21,422	21,269
Compensation	$99,273,962	$102,756,301	$104,903,187	$89,689,765	$74,899,674	$67,939,475	$65,702,143
Total employees:							
Average number	26,222	27,386	28,563	27,085	25,807	23,752	23,497
Compensation	$114,556,137	$116,856,618	$118,080,993	$101,128,010	$ 84,446,256	$76,247,587	$73,563,475



For Best Application Performance in Extreme Temperatures

Specify PITT CHEM PLASTICIZED Grade Pipeline Enamel

Pitt Chem Plasticized Enamel is specially compounded to maintain its excellent application characteristics and bond under virtually all conditions encountered at temperatures ranging from -20° F. to 160° F.

You can count on its consistent high quality, too, because we're a basic producer and control each phase of production from coal to finished coating—in a plant *specifically* designed for manufacturing hot applied pipeline enamel. And because we're basic, we've never failed to meet a delivery deadline.

● *We're always ready to help you do a better and faster pipeline coating job. Just drop us a line and we'll immediately send you specification sheets and technical information . . . or provide the field application assistance you need.*

- ☆ Standard Grade Tar Base Enamel
- ☆ Modified Grade Tar Base Enamel
- ★ Plasticized Grade Tar Base Enamel
- ☆ Cold Applied Tar Base Coatings
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W&D 3961

PROTECTIVE COATINGS DIVISION

PITTSBURGH COKE & CHEMICAL CO.

Grant Building • Pittsburgh 19, Pa.

COAL CHEMICALS • AGRICULTURAL CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

TABLE 3. Pipe line mileage operated at close of year, by individual companies.

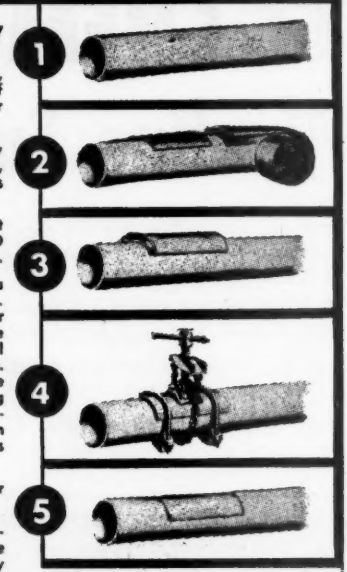
Name of company	Trunk line: Grand total	Trunk line: Total	Trunk line: Crude oil	Trunk line: Refined oils	Gathering line, crude oil
Total mileage operated	128,589	80,996	64,622	16,374	47,593
Ajax Pipe Line Corp.	819	819	819	.....	.....
American Petroleum Co.	155	86	86	.....	69
Anderson-Prichard Pipe Line Corp.	127	.....	.....	.....	127
Arkana Transit Corp.	69	35	35	.....	34
Arkansas Pipeline Corp.	[1]518	[1]272	[1]272	.....	[1]246
Atlantic Pipe Line Co.	[2]2,228	[2]1,693	[2]1,690	3	535
Atlas Processing Co.[3]	.....	.....	.....	.....	.....
Bell General Pipe Line Co.	171	40	40	.....	131
Bell Oil & Gas Co.	140	10	.....	10	130
Bell-Western Corp.	51	35	35	.....	16
Bradford Transit Co.	688	.....	.....	.....	688
Buckeye Pipe Line Co.	6,101	3,046	2,770	276	3,055
Buffalo Pipe Line Corp.	161	161	.....	161	.....
Canadian Trunk Line	10	10	10	.....	.....
Cities Service Pipe Line Co.	[4]821	[4]315	[4]315	.....	[4]506
Claiborne Pipeline Co.	38	38	.....	38	.....
Cleveland Pipe Line Co.	18	18	18	.....	.....
Continental Pipe Line Co.	[5]1,906	.....	.....	.....	[5]1,906
Cooperative Refinery Assn.	979	242	241	1	737
Crown Central Pipe Line	1	1	.....	1	.....
Detroit Southern Pipe Line Co.	85	85	.....	85	.....
Eureka Pipe Line Co.	3,646	510	510	.....	3,136
Freedom-Valvoline Oil Co.	1,449	297	297	.....	1,152
Globe Pipe Line Co.	11	11	11	.....	.....
Great Lakes Pipe Line Co.	4,233	4,233	.....	4,233	.....
Gulf Refining Co.	10,034	6,772	6,448	324	3,262
Humble Pipe Line Co.	9,355	5,987	5,711	276	3,368
Illinois Pipe Line Co. of Texas	108	.....	.....	.....	108
Interstate Oil Pipe Line Co.	4,459	3,063	3,063	.....	1,396
Kaw Pipe Line Co.	1,222	.....	.....	.....	1,222
Keystone Pipe Line Co.	700	700	3	697	.....
Lakehead Pipe Line Co., Inc.[6]	324	324	324	.....	.....
Magnolia Pipe Line Co.	8,754	5,977	5,574	403	[7]2,777
Michigan-Ohio Pipeline Corp.[8]	309	309	309	.....	.....
Mid-Valley Pipeline Co.	1,001	1,001	1,001	.....	.....
National Transit Co.	2,695	892	881	11	1,803
New York Transit Co., Inc.	184	184	184	.....	.....
Northern Pipe Line Co.	624	624	624	.....	.....
Ohio Oil Co.	3,964	2,807	2,807	.....	1,157
Ohio River Pipe Line Co.	2	2	2	.....	.....
Pan-Am Southern Corp.	54	.....	.....	.....	54
Pan American Pipe Line Co.	1,118	534	534	.....	584
Phillips Petroleum Co.	[9]1,796	[9]1,796	.....	[9]1,796	.....
Phillips Pipe Line Co.	2,050	1,215	1,207	8	835
Plantation Pipe Line Co.	1,261	1,261	.....	1,261	.....
Portland Pipe Line Corp.	341	341	341	.....	.....
Project Five Pipe Line Corp.	150	150	.....	150	.....
Pure Transportation Co.	1,286	420	413	7	866
Richardson Pipe Line Co.[10]	.....	.....	.....	.....	.....
Rocky Mountain Pipe Line Co.	298	298	298	.....	.....
Salt Lake Pipe Line Co.	782	755	186	569	27
Service Pipe Line Co.	11,406	8,205	8,205	.....	3,201
Shamrock Oil & Gas Corp.[11]	.....	.....	.....	.....	.....
Shell Pipe Line Corp.	[12]5,252	[12]3,922	[12]3,617	305	1,330
Sinclair Refining Co.	[13]13,498	[13]7,919	[13]5,085	2,834	5,579
Socony-Vacuum Oil Co., Inc. — White Eagle Pipe Line Division	112	.....	.....	.....	112
Sohio Pipe Line Co.	2,034	779	779	.....	1,255
Sohio Western Pipelines, Inc.	59	.....	.....	.....	59
South West Pennsylvania Pipe Lines	1,636	410	410	.....	1,226
Southeastern Pipe Line Co.	479	479	.....	479	.....
Southern Pipe Line Co.	311	311	311	.....	.....
Sun Pipe Line Co.	1,313	664	664	.....	649
Sunray Pipe Line Co.	84	84	.....	84	.....
Susquehanna Pipe Line Co.	992	992	3	989	.....
Texas-Empire Pipe Line Co.	1,948	1,948	1,948	.....	.....
Texas-New Mexico Pipe Line Co.	2,530	1,264	1,264	.....	1,266
Texas Pipe Line Co.	[14]6,164	[14]3,772	[14]3,361	411	2,392
Tidal Pipe Line Co.	178	20	20	.....	158
Tide-Water Pipe Co., Ltd.	576	576	576	.....	.....
Toronto Pipe Line Co.	343	.....	.....	.....	[15]343
Transit & Storage Co.	451	451	451	.....	.....
Triangle Pipeline Co.	152	135	.....	135	17
Tri-State Refining Co.[16]	42	42	42	.....	.....
Tuscarora Oil Co., Ltd.	569	569	13	556	.....
Utah Oil Refining Co.	896	817	814	3	79
Wyco Pipe Line Co.	268	268	.....	268	.....

[1] Includes 20 miles (trunk line) 12 miles (gathering line) owned with Cities Service.
[2] Includes 44 miles leased from Richardson Pipe Line Co.
[3] Mileage not operated at close of year.
[4] Excludes mileage jointly owned with other companies. See footnotes 1 and 14.
[5] Excludes 24 miles of Toronto Pipe Line Co.'s portion of jointly owned mileage.
[6] Report for period Nov. 10 to Dec. 31, 1950.
[7] Includes 18 miles used in gathering refined oils.
[8] Report for period Sept. 1 to Dec. 31, 1950.
[9] Includes 318 miles jointly owned with Shamrock Oil & Gas Corp.
[10] Nonoperating company. Mileage leased to Atlantic Pipe Line Co.
[11] Mileage jointly owned with Phillips Petroleum Co. (acting as operator). See footnote 9.
[12] Excludes respondent's portion of Basin Pipe Line System. See footnote 14. Includes 439 miles of Ozark Pipe Line System jointly owned with Texas Pipe Line Co.
[13] Excludes mileage jointly owned with other companies. See footnote 14.
[14] Includes 521 miles of Basin System owned with Cities Service, Shell, and Sinclair. Excludes mileage of Ozark System owned with Shell. See footnote 12.
[15] Excludes 25 miles of Continental Pipe Line Co.'s portion of jointly owned mileage.
[16] Report for period April 1 to Dec. 31, 1950.

STOPS PIPE LINE LEAKS

SIMPLY and QUICKLY

1. Whatever size leak may be, simply cut necessary length of GRO-CORD gasket to cover generously.
2. Cut a piece of plate, or any ready-made half sole or sleeve, to extend about 1" on both sides and both ends of the gasket.
3. Fit plate over the gasket so it extends beyond the GRO-CORD pipe repair gasket on all sides.
4. Clamp repair tight with a chain jack to shut off the leak. Use clamps to hold plate or half sole in contact with the pipe at all points. Weld all around and REMOVE CLAMPS. If desired, chain jack may be left indefinitely until welding equipment is available. Gro-Cord gaskets have been in service as long as 5 years before final weld.
5. Permanent welded repair after chain jack removed.



Specially shaped Gro-Cord pipe repair gaskets are used by pipe line companies everywhere. Actually tested at 1600 p.s.i., Gro-Cord will not deteriorate. Oil resistant cotton impregnated stock lasts for years.

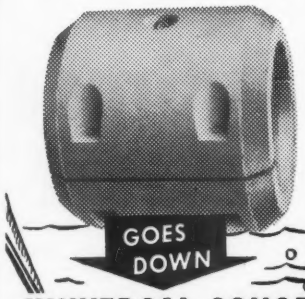
SERVING OIL INDUSTRY 17 YEARS

Jobber Inquiries Invited!
May be used with welded or clamped repairs. Write for folder OGJ 49.

GRO-CORD
PIPE REPAIR GASKETS

DALLAS MANUFACTURING & SALES COMPANY
POST OFFICE BOX 7181 DALLAS 9, TEXAS

Protect lines crossing small streams and rivers from tides, floods, strong currents and shifting sands. Count on Universal river weights (reinforced concrete clamps) and be sure your line goes *down* and *stays down*. Details and literature on request.

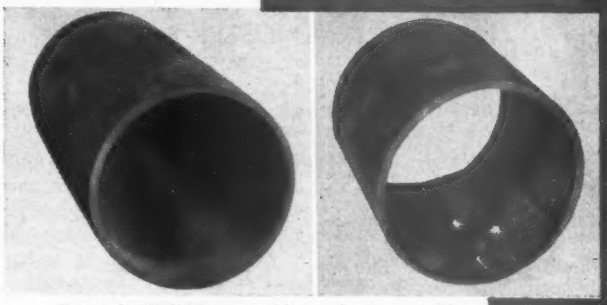


UNIVERSAL CONCRETE RIVER WEIGHTS

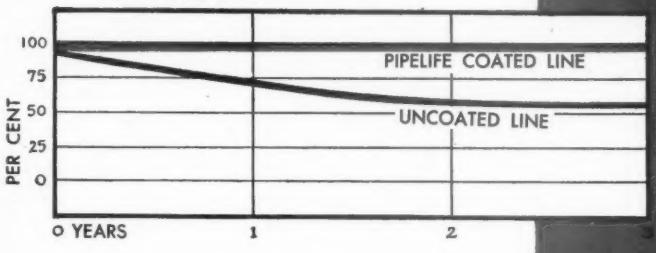
LET'S FACE FACTS

INTERNAL PIPELIFE PROTECTION PAYS BIG DIVIDENDS!

Reclaim old pipe — protect new pipe with the PIPELIFE plastic coating process. The first and only pressure method for internally cleaning and plastic coating pipelines IN PLACE! Using a patented and scientifically designed coating plug, the PIPELIFE process is the only method which can assure a uniform coating throughout the entire line. It is a field tested and time proven process — over a million feet of pipeline having been successfully cleaned and coated since April 1948.

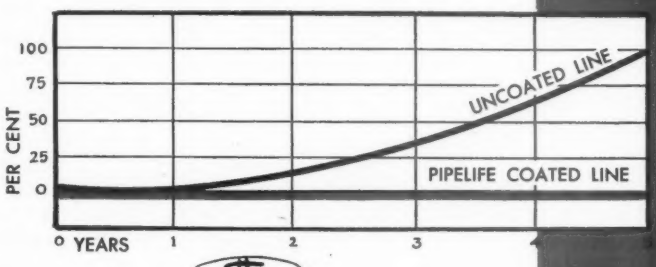


Photos of a PIPELIFE protected line and an uncoated line after three years actual service. Both are sour crude lines near Odessa, Texas.



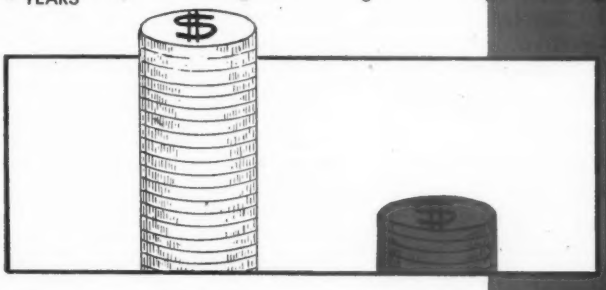
MAXIMUM FLOW EFFICIENCY

PIPELIFE assures years of maximum efficiency while the efficiency of the average uncoated line in a corrosive area is constantly decreased by internal corrosion and scale and paraffin depositions.



ELIMINATES INTERNAL CORROSION

PIPELIFE stops pipe deterioration caused from internal corrosion — adds years of life to priceless lines.



PIPELIFE COSTS LESS!

The total cost of a PIPELIFE treated line, such as the sour crude lines now being used in the Permian Basin is only ONE FIFTH the cost of maintaining the same section of uncoated line.

FOR THE LIFE OF YOUR PIPE — "PIPELIFE"

PIPELINES CLEANED AND PLASTIC COATED INTERNALLY — IN PLACE

PAYS BIG DIVIDENDS — INTERNAL PIPELINE MAINTENANCE

PIPELIFE, INC.

BOX 1711 ODESSA, TEXAS 1604 W. 2ND

TABLE 4. Investment in carrier property, by primary accounts.

Account	Balance at beginning of	Property changes during the year: Expenditures for new construction and improvements	Expenditures for existing property purchased or otherwise acquired	Credit	Net	Transfers, clearances, and adjustments, prior years	Increase or decrease during the year	Balance at close of year
Gathering Lines								
Land	$360,533	$6,456	$809	$9,917	d $2,652	d $104	d $2,756	$357,777
Rights-of-way	4,096,795	365,732	10,338	136,360	239,710	d 11,695	228,015	4,324,810
Line pipe	82,380,622	6,871,638	254,561	3,466,842	3,659,357	d 215,624	3,443,733	85,824,355
Line-pipe fittings	8,871,083	1,230,026	20,530	471,831	778,725	d 10,014	768,711	9,639,794
Pipe line construction	53,026,797	5,706,646	122,446	1,995,692	3,833,400	d 165,460	3,667,940	56,694,737
Buildings	6,956,747	341,128	18,035	320,969	38,194	d 4,389	33,805	6,990,552
Boilers	47,761	1,048	.....	1,541	d 493	.....	d 493	47,268
Pumping equipment	18,135,742	2,789,284	56,481	1,548,361	1,297,404	d 84,535	1,212,869	19,348,611
Machine tools and machinery	187,056	11,792	47	4,348	7,491	d 153	7,338	194,394
Other station equipment	4,025,680	603,534	18,497	268,558	353,473	d 2,667	350,806	4,376,486
Oil tanks	10,719,932	1,284,134	19,255	518,074	785,315	d 49,012	736,303	11,456,235
Delivery facilities	1,526,580	47,898	.....	93,056	d 45,158	d 94,657	d 139,815	1,386,765
Communications systems	2,618,558	88,798	3,571	96,537	d 4,168	d 12,299	d 16,467	2,602,091
Office furniture and equipment	359,023	31,605	1,402	7,740	25,267	2,171	27,438	386,461
Vehicles and other work equipment	2,047,811	550,168	139,166	322,417	366,917	d 48,904	318,013	2,365,824
Other property	332,451	116,398	.....	21,036	95,362	d 226	95,136	427,587
Total	195,693,171	20,046,285	665,138	9,283,279	11,428,144	d 697,568	10,730,576	206,423,747
Trunk Lines								
Land	6,252,728	475,344	2,705	295,435	182,614	d 132,092	50,522	6,303,250
Rights-of-way	25,230,007	3,152,864	88,939	651,815	2,589,988	d 183,832	2,406,156	27,636,163
Line pipe	480,496,809	72,719,570	1,029,437	10,650,739	63,098,268	d 549,397	62,548,871	543,045,680
Line-pipe fittings	22,107,292	3,928,290	20,805	935,674	3,013,421	361,894	3,375,315	25,482,607
Pipe line construction	354,900,620	67,195,445	629,631	7,427,021	60,398,055	448,473	60,846,528	415,747,148
Buildings	63,250,240	5,011,282	29,630	2,223,774	2,817,138	d 152,440	2,664,698	65,914,938
Boilers	439,698	18,512	52	88,314	d 69,750	d 12,122	d 81,872	357,826
Pumping equipment	88,898,751	6,713,235	48,131	4,000,896	2,760,470	215,444	2,975,914	91,874,665
Machine tools and machinery	822,046	38,986	300	22,546	16,740	91,637	108,377	930,423
Other station equipment	54,326,232	7,472,045	23,878	2,402,996	5,092,927	d 578,199	4,514,728	58,840,960
Oil tanks	92,371,157	11,150,102	76,395	2,234,348	8,992,149	d 66,681	8,925,468	101,296,625
Delivery facilities	15,772,689	1,577,205	181	402,028	1,175,358	214,548	1,389,906	17,162,595
Communication systems	19,128,519	762,413	16,242	416,650	362,005	d 56,939	305,066	19,433,585
Office furniture and equipment	1,275,682	189,082	3,287	41,460	150,909	10,129	161,038	1,436,720
Vehicles and other work equipment	7,758,451	2,058,103	25,238	1,183,149	900,192	d 44,187	856,005	8,614,456
Other property	4,684,667	424,412	13,032	253,950	183,494	d 472,171	d 288,677	4,395,990
Total	1,237,715,588	182,886,890	2,007,883	33,230,795	151,663,978	d 905,935	150,758,043	1,388,473,631
General								
Land	223,871	4,285	.....	1,270	3,015	d 5,137	d 2,122	221,749
Buildings	6,969,831	749,789	.....	42,838	706,951	d 52,620	654,331	7,624,162
Machine tools and machinery	599,966	29,812	.....	4,650	25,162	d 94,340	d 69,178	530,788
Communication systems	1,698,821	343,864	.....	79,249	264,615	d 29,934	234,681	1,933,502
Office furniture and equipment	1,953,691	407,047	22	129,288	277,781	d 13,953	263,828	2,217,519
Vehicles and other work equipment	6,853,717	1,681,288	6,559	1,321,866	365,981	96,600	462,581	7,316,298
Other property	576,947	27,879	.....	1,231	26,648	d 331,399	d 304,751	272,196
Construction work in progress	44,028,409	d 5,254,381	4,250	12,491	d 5,262,622	945,556	d 4,317,066	39,711,343
Unadjusted investments	1,442	.....	.....	.....	.....	.....	.....	1,442
Acquisition adjustment	1,263,535	d 162	.....	16,889	d 17,051	.....	d 17,051	1,246,484
Total	64,170,230	d 2,010,579	10,831	1,609,772	d 3,609,520	514,773	d 3,094,747	61,075,483
Grand Total	1,497,578,989	200,922,596	2,683,852	44,123,846	159,482,602	d 1,088,730	158,393,872	1,655,972,861

d Deficit or other reverse item.

nual reports filed by carrier pipe lines. Pipe line companies are subject to the jurisdiction of ICC if they are common carriers engaged in the interstate transportation of oil or other commodity (except water and natural or artificial gas) by pipe line, or partly by pipe line and partly by railroad, or by water.

The Interstate Commerce Commission received reports from 77 companies for the year of 1950, 3 more than filed for the year 1949. Thirteen of the 77 reports relate to pipe line departments of large oil companies. Table 2 excludes figures for capitalization, surplus, and dividends for such pipe line departments because these items are not segregated in the reports. Other items in the table include data from a varied number of such reports, as well as from reports of agency operation by the Reconstruction Finance Corporation, for the years 1944 through 1950. The substitution of departmental or agency reports for corporate reports affects the comparability of items specified in Table 2 other than investment and operations for the years 1944 through 1950, and with corresponding items for earlier years. Table 1 excludes complete data for the 13 companies that filed reports relating to pipe line departments of large oil companies for the same reason as stated in the case of Table 2.

Statistics on barrel-miles of oil transported relate to trunk line movement. The schedule in the annual report form for pipe line companies relating to statistics of operations shows the total number of barrels of crude and refined products received into the system and the total number delivered out of the system, with a subdivision of each of these items to show connecting carrier traffic separately from that originated or terminated. * * *

Gas Revenues Show Increase

Operating revenues of natural gas companies reporting to the Federal Power Commission totaled $99,822,900 in September, 1951, an increase of 16 per cent over September, 1950 receipts of $86,082,467. For the 12 months ended September 30, revenues aggregated $1,495,706,040 or 22.6 per cent higher than the $1,220,052,612 received in the 12 months ended September 30, 1950.

Gas utility operating income for September 1951 amounted to $8,402,200, up 10.1 per cent from the $7,629,666 reported for September of last year. For the 12 months ending with September, 1951, gas utility operating income was $228,784,479, representing an increase of 10.9 per cent over the $206,256,125 reported for the comparable period ending in September 1950.

Net gas utility plant of the reporting companies aggregated $3,584,712,588 on September 30, 1951, up $580,358,012, or 19.3 per cent over the $3,004,354,576 reported a year ago.

Net income for September, 1951, was $3,990,786, down 19.4 per cent from the September, 1950, net of $4,950,769. However, net income of $180,356,943 for the 12 months ending September, 1951, represented an increase of 3.4 per cent over the $174,476,218 realized in the comparable period ending September 1950.

Steel for Pipe Lines—Who Gets What and When*

An explanation of the basis for PAD's allotments to specific projects

GEORGE A. WILSON†

THIS session of the American Petroleum Institute provides an unusually advantageous meeting ground for an interchange of information and ideas between the oil industry and government defense agencies. We now have had nearly a year of experience in the trials and tribulations of a defense economy. I am sure that neither you nor we have relished these arrangements, however necessary they might be. Nevertheless, since the oil industry probably will have to continue operating within this framework of regulations and restrictions for some additional time, this meeting does offer an excellent means of furthering your acquaintance with the background and workings of those agencies connected with petroleum transportation. In that connection, I would like to tell you something about the activities of the Supply and Transportation Division of the Petroleum Administration for Defense.

While I do not avidly seek opportunities to stand upon a rostrum, yet this is an instance when I must confess that I welcome the opportunity. I do so because I believe I may be able to give you—as the core of the transportation branch of the oil industry—some background and suggestions that may be helpful to you, to the oil industry as a whole and to the Petroleum Administration for Defense relative to our joint efforts to achieve mobilization objectives.

There are many aspects of our work in connection with transportation in the petroleum industry that might be of interest to you. The field is broad and complex. But in endeavoring to be helpful to you, I shall relate my remarks principally to controlled materials and their allocation.

This approach seems appropriate since the allocations of those materials largely will determine the extent and direction of growth of pipe line transportation during the period of these partial controls. In addition—depending upon whether we bureaucrats have approved your particular application or have held it in abeyance—this is the field of action where you probably most frequently are tempted to commend our obvious wisdom, our lack of bias and our long experience and wide knowledge in oil industry operations, or you are confounded and aroused by our apparent stupidity, our crass favoritism, our ignorance of the vital needs of the industry and our general lack of good judgment and common sense!

A general appraisal of our brief experience in allocating controlled materials to petroleum projects necessitates answers to two principal questions:

1. How much material has our division of the Petroleum Administration for Defense had available to distribute?
2. What have been the bases of our allotments to specific projects? In other words, how have we decided who gets what and when?

With the shortage of steel, copper, and aluminum existing today, the Petroleum Administration for Defense is allotted only limited quantities of these materials by the Defense Production Administration for each calendar quarter. These allotments must cover all construction projects in the oil and gas industries. The total quantities made available are considerably smaller than would be required to permit construction of all the projects that the many companies in these two main branches of the petroleum industry desire to complete.

As an applicant, it understandably is discouraging and irritating if your company has made a careful analysis of the justification for a new pipe line or oil terminal and has approved a sizable expenditure for such a project, only to find that the Petroleum Administration for Defense delays allotment of the controlled materials that are necessary for you to proceed with the work. No doubt at such a time you wonder what kind of theoretical standards, haphazard judgment, or bureaucratic slowdown conceivably could intervene to delay such construction if your company is ready to take the financial risks involved. Certainly under normal conditions our free enterprise system channels money into those new facilities that are judged most necessary on the basis of competition for the same money in an unlimited variety of alternative possibilities. If it is considered a good investment by your company, then why not by PAD? This is a perfectly normal reaction grounded in the experience of good business practice. Yet today, unfortunately, willingness to risk your capital cannot be the sole determinant. Steel, copper, and aluminum are not available in adequate quantities for all the construction projects that all the companies in the industry are willing to undertake.

Under these circumstances, it is essential that the controlled materials available to the Petroleum Administration for Defense be allotted so as to accomplish expansion where the need is greatest from an overall industry standpoint. Moreover, granted several equally urgent projects, the available materials must go first to those jobs where the most can be accomplished for the smallest investment of scarce materials.

Since steel is the controlled material utilized in greatest volume in the construction of pipe lines and terminals, the amounts of steel available to us for these needs largely determine the extent of construction of such facilities in the industry. Hence, let us look at our experience in steel availability as a measure of our problems under the Controlled Materials Plan.

For the last two quarters of 1951 our total allocations of steel for construction of all oil pipe lines and terminals were much below desirable minimums. Combining totals for these two quarters, our requests have been for a minimum total of 895,000 tons of carbon steel for the construction of oil pipe lines and terminals. Our nominal allotments totalled only 514,000 tons, or less than 58 per cent of the minimum we had sought to obtain.

These minimums were not figures picked out of thin air, nor had they been inflated to serve as bargaining points from which we could do some horse trading to a more reasonable level. The minimum amounts of steel we had requested had no padding that could be sliced off and hence the reduction in allotments simply precluded the allocations of steel to many pipe line and terminal projects that we knew were vital to achieving defense mobilization objectives.

The requests we make for steel for pipe line transportation of oil and for oil storage tanks are based principally upon a truly monumental study of the industry, which was completed in July of this year. This detailed study was undertaken in January as the outgrowth of a recommendation of the National Petroleum Council in November of 1950. At that early stage in our mobilization activity, the council wisely recognized the need for a comprehensive study of oil transportation facilities if the Petroleum Administration for Defense were to meet its responsibilities in the mobilization effort.

Being fully conscious of the likely development of shortages in critical materials, it was intended that the study would establish minimum goals based

*Presented before Transportation Division, American Petroleum Institute, Chicago, Illinois, November 7, 1951.

†Director, Supply and Transportation Division, Petroleum Administration for Defense, Washington, D. C.

upon necessary expansion, not simply upon general "guestimates" or horseback hunches. It also was to serve as a basis for *limiting* our requests for scarce materials to essential needs within the framework of mobilization — but not wartime—objectives. The completed study attains the goals of the National Petroleum Council handsomely.

Under the direction of one of the industry's leading economists, John W. Boatwright, qualified specialists from the various branches of the petroleum industry devoted six months to this intensive investigation. The study presents analyses of probable future demand, estimated future refinery capacity, and estimated future producibility of crude oil and natural gas liquids. These three fundamental yardsticks were studied in detail by regional areas, thus establishing minimum transportation requirements to provide an integrated flow from the well head to the thousands of points of essential need throughout the country.

A number of the men who were members of this group have remained with us to keep the study current as changes occur in military needs and in civilian requirements on the one hand, or as substantial additional supplies of crude are found or more refining capacity constructed at various locations not previously contemplated.

We have hopes that the transportation study soon will be available to you as a guide in planning your expansion. As such, it should have great value. It presently is being printed and should be on issue at the Government Printing Office at an early date.

In the meantime, it has and will continue to serve as a general blueprint for our materials needs in the mobilization period. It also will guide us in allocating steel at our disposal in order to give proper priority to those projects which fulfill fundamental needs in the framework of our mobilization objectives.

Tickets for Pipe Line Steel

Let us look now at the industry's experience in translating our allocations of paper steel into actual hardware. If some of you were fortunate enough to receive allotments of steel for pipe line construction out of the limited amounts available to us in the third and fourth quarters of 1951, you probably know that not all of our allotment "tickets" automatically guaranteed delivery of steel. Some tickets simply could not be cashed. As a result, by the latter part of October, we already had been forced to revalidate more than 37,000 tons of line pipe into the first and second quarters of 1952 because it could not be obtained in the quarters when originally allotted. We are continuing to receive requests for revalidations and it appears that the final total of such shifts from the last two quarters of 1951 to quarters in 1952 very likely will be quite sizable.

Since large bulk storage tanks are a necessary element in petroleum transportation, a brief reference should be made to our experience in obtaining steel for field erected tank construction. I will not burden you with figures regarding the amounts of steel requested compared with that obtained. Suffice it to say that here again we received nominal allotments considerably below the minimum we considered essential.

Tank Construction Supply

In addition, I am sorry to report that the experience of the industry in cashing in our steel allotment tickets for tank construction has been even more discouraging than in the case of line pipe. A considerable portion of our third and fourth quarter allotments had to be shifted to subsequent quarters. Already more than 20 per cent of the total tank steel allotted for the fourth quarter has been revalidated into subsequent quarters even though we have discouraged requests for such action. Based upon information available in mid-October, it appears quite probable that more than 25 per cent of our fourth quarter tank steel ultimately will have to be revalidated into subsequent quarters. Of necessity this will reduce the amount of such steel available for additional projects. As a result, we either will require compensating additional amounts of steel or we will fall further behind in progress toward the minimal goals established.

The foregoing record is not repeated here as a criticism of the Defense Production Administration, National Production Authority, or of those responsible for apportioning steel among the several basic operating divisions within PAD. They have allocated steel on the basis of their best judgment of essentiality of needs. The Controlled Materials Plan is a complicated mechanism and like any new plant or operation, it has had bugs and kinks that we hope will be eliminated or minimized as we go along.

Allocations of steel for oil pipe lines and tanks during the first quarter of 1952 came somewhat closer to the essential minimums that are considered necessary than did our allocations in the previous two quarters. Since the total first quarter allocation of steel to PAD as a whole again is much below the minimum that had been requested—1,708,500 tons allotted against 2,100,000 tons asked — the increased quantity available for construction of oil pipe lines and tankage simply reflects a different division of the total PAD community property, rather than a general improvement for all petroleum purposes.

To some degree this adjustment in the relative portion of our allocation reflects a decision during the past summer. Most of the steel available to the PAD for large diameter pipe is utilized in the construction of trunk lines for oil transportation or for natural gas transmission lines. At the beginning of the operation of the Controlled Materials Plan, several important large gas lines were under construction. Completion of those lines prior to the coming winter was considered essential. Accordingly, steel was made available for them as a primary need within the limits of the relatively small total quantities at the disposal of PAD. In effect, this tended to slow down or postpone construction of oil pipe lines with a compensating shift in emphasis anticipated in subsequent periods. The division of steel for large diameter pipe between oil and gas in the first quarter of 1952 reflects this essential shift in emphasis.

Requests vs. Allocations

For the first quarter of 1952, we had requested an allocation of 400,000 tons of pipe. We were allotted 368,000 tons. We asked for 63,000 tons of plate for tanks for normal oil industry construction and MRO. We received a total of 65,000 tons but must supply from that quantity at least some part of the sizable program of the military for oil tankage construction.

Lest you prematurely assume that these comparative data portend the arrival of the millennium, I hasten to point out the following:

1. The steel requested represented rock bottom minimums and was by no means adequate to permit allocation of steel to all projects having merit.
2. Revalidations of ineffective allotments from previous quarters will use up sizable amounts of each type of steel available to us in our first quarter allocations.
3. A presently unknown, but significant, tonnage of the plate for tanks has to go to storage projects required by the military. Some pipe also will have to be assigned to such projects.

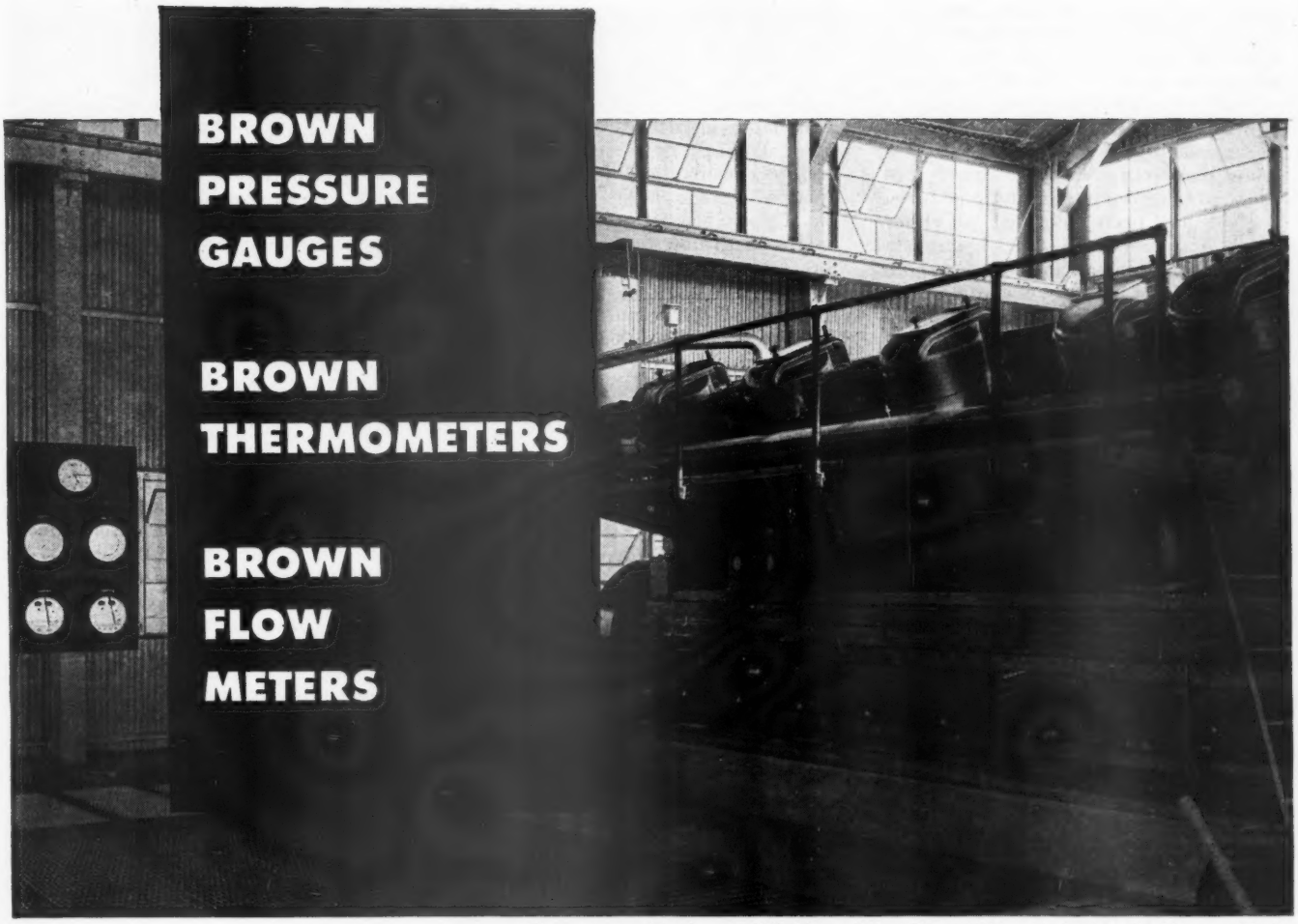
Despite the improvement that has occurred, sufficient steel will not be available for all pipe line and storage projects in the first or even the second quarter of 1952. On the contrary, many good projects that should be finished soon will have to be delayed until late in 1952 and perhaps into 1953 unless substantial improvement in the availability of materials is achieved.

Now I would like to get on to the second question in the general appraisal of our allocation of controlled materials. That is, what have been the bases of our allotments of steel to specific projects? Or putting it another way, how have we decided who gets controlled materials in a given quarter from the limited amounts available to us?

Except when direct defense needs are involved, or maintenance of vital existing facilities, allocations of steel for pipe lines, and tankage go wherever they will accomplish the most for the smallest expenditure of steel.

In crude oil pipe line construction, this normally has involved getting crude oil to the market out of producing areas that otherwise would be shut in. For example, it has led us to concentrate a sizable portion of our total steel for pipe in trunk lines moving crude out of West Texas to the Gulf Coast and out of the Rocky Mountain area into District II.

In like manner, pipe has been allocated for construction of crude oil



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gathering lines in producing areas not already served by existing lines. Many, many projects of this type receive pipe allocations as rapidly as we have steel available to distribute. They deserve a top rating in our allocation. Conversely, we cannot afford to allocate steel for crude lines into areas that already are adequately served by existing pipe lines.

Steel has been allocated to either crude or products pipe lines only when existing alternative transportation quite definitely could not meet essential needs. We have been unable thus far to justify allocations of steel for pipe line expansion or construction solely to provide cheaper transportation or to improve the competitive position of a given company or group of companies. When steel is that plentiful, we as government should no longer have anything to say about where it goes.

Allocation of steel for tanks for seasonal storage at a marine or pipe line terminal is highly desirable if the proposed tankage is to be located in an area of consumption. Such tankage for seasonal storage in New England or on the Upper Mississippi River, for example, contributes significantly toward flattening the transportation load through the year. If we consider that the demand for ocean-going tankers in January generally exceeds average need through the year by about 15 per cent, then we can appreciate the value in locating seasonal storage where the product is consumed. Most of you are familiar with the seasonal variation in tanker rates that reflects these crests and troughs in need during the year and give an indication of the dollar cost of inadequate seasonal storage capacity in the areas of consumption.

The same bulge in the seasonal need for transportation applies to tank cars and barges. For that reason, we will favor those seasonal storage projects that provide new tankage where the product will be used. However, this does not mean that we can approve projects for just any arbitrary amount of tankage. In order to be fair to all applicants for tank steel, we must limit steel allocated for each such project to the amount required to permit reasonably even monthly deliveries to the terminal throughout the year.

To avoid excessive allocations for some projects, we regularly ask for data on present annual and seasonal movements through such tanks. This is the only way we have of applying a common yardstick to all such applications. Other factors will help determine whether we can allocate steel to the project at all. This yardstick goes a long way toward determining *how much* steel we can allocate based upon the barrels capacity that appear to be justified to meet present seasonal needs without excessive seasonal bulges in transportation requirements.

Generally speaking, the Supply and Transportation Division recommendations for allocations of tank steel will favor the colder northern areas during the second and third, or summer quarters. This seems to us to be logical for two reasons. First, construction is more costly and hazardous in the North during the winter. Secondly, most seasonal storage erected during the winter is of little value in delivering product to consumers until the following winter; hence, construction in the summer will be just as valuable from an industry or from an area viewpoint. True, this arrangement may result in tight scheduling on completion and filling of tankage erected with third quarter steel. This is recognized but any alternative is believed to have even more weaknesses.

The foregoing general principles and objectives are guides in the analysis of applications on PAD 26 forms that come under the cognizance of the Supply and Transportation Division of the Petroleum Administration for Defense. Our analysts virtually all are on leave from jobs in the oil industry and as such have a good general background and knowledge of oil industry operations. More than half are engineers who have been helping to run pipe lines or engaged in other technical work in the industry. The others are equipped with equally desirable backgrounds in other types of transportation or in supply activities in the industry. As a result we have a general cross-section of technical skills and practical experience that can be brought to bear in our analyses and recommendations.

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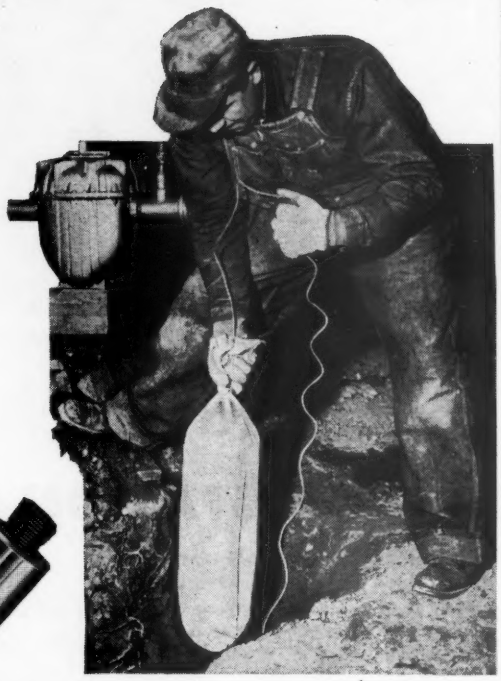

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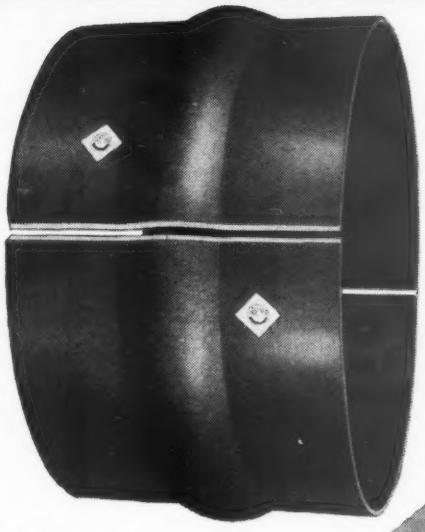

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which steel is requested is analyzed by one of the members of the division who prepares a recommendation for our own division's review committee. Here we have adequate representation from within our division to correlate the handling of related projects and to bring to bear a combined experience that helps maintain common standards of judgment on projects of comparable essentiality. Projects that appear adequately essential (to our divisional review committee and to me) to merit allocation of steel from the limited quantity at our disposal, go forward to two general PAD review committees.

The first of these is known as the Domestic Operations Facilities Committee and the second as the Facilities Review Committee. At each level, projects of doubtful essentiality may be returned for further analysis, for postponement or for other disposition. These reviews are an important assurance to industry that our allocations will be based upon a general grading of essentiality and upon uniform standards that apply for all phases of oil industry operations.

Before closing, I would like to return again for a moment to our analyses of your applications. It will be to your advantage and to ours if you give us the most complete information possible. We cannot allocate steel blindly to an applicant simply because he sends in a PAD 26. As long as steel is scarce and as long as we have less than enough to go around, we must give priority to those projects that appear to be most essential. However, to judge essentiality, we must have sound data on volume of throughput, on service to be rendered, and all other information that will support your claims of essentiality. We cannot act simply because the application contains a statement saying the project is important.

Since we have particularly small amounts of copper, aluminum, and stainless steel at our disposal, we are very much interested in the exact usage of any that is requested on a PAD 26 application. It will save time for you and us, if you explain such needs in detail in all applications for pipe line or storage projects.

In like manner, to verify the tonnage of steel requested, we must have blueprints, layout diagrams or similar information establishing the need for the amounts specified. It will save you and us time and effort if such information is contained in your original application.

Now, one final but most important suggestion. Most applications we receive for both pipe lines and terminals ask for an allotment of all the steel required in the current or succeeding quarter. Obviously, this cannot always be done. Even a year or two ago you usually had to have an order in longer to get deliveries. Without limited allocations today, it simply is impossible to allocate on that basis.

I believe you will agree from the foregoing birdseye view, that our job, pertaining to controlled materials, is not simple or unimportant. Yet, it is only one of the activities handled by a small but high calibre group of men working on supply and transportation problems in PAD. Working in cramped quarters, in four small offices, about a dozen men have had to handle all PAD 26 applications, all applications for Certificates of Necessity for accelerated tax amortization, and all other activities coming under the jurisdiction of the Supply and Transportation Division of PAD. They have done an outstanding job, while sacrificing at least personal comfort and convenience. The government and industry owe them a vote of thanks.

The companies that have made these men available also deserve a vote of thanks. Our calls for help generally have met with a prompt and unselfish response. However, in getting some of their best men, we must recognize that the periods of government service must be limited so that the same few men from a few companies do not continue to carry the entire load. Replacements will be needed. We hope that particularly those companies that have not yet made men available will do so as replacements are required.

In closing, let me say that we have much appreciated the splendid cooperation we have had from the oil industry in our work handling controlled materials and in all of our other activities. Nearly without exception, our requests have had prompt, courteous, and competent attention. This is most helpful. *

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TANK POCKETS REMOVED BY NEW METHOD

Mud jacking proves economical process in the area where non-uniform settlement of soil caused sags in tank bottom.

JOHN MONTFORT*

THE Mid-Valley Pipeline Company, at its Mayersville, Mississippi, pump station and terminal, has demonstrated a new method for removing deep pockets in tank bottoms that have developed as a result of non-uniform settlement of the soil. The method is known as mud jacking.

The Mayersville location is in that section of the Mississippi River Delta country characterized by silty clay soil (buckshot), which has an extremely low bearing capacity, the practical maximum being approximately 1000 lb per square foot. Most major structures throughout the Delta, as a matter of fact, are supported on piling.

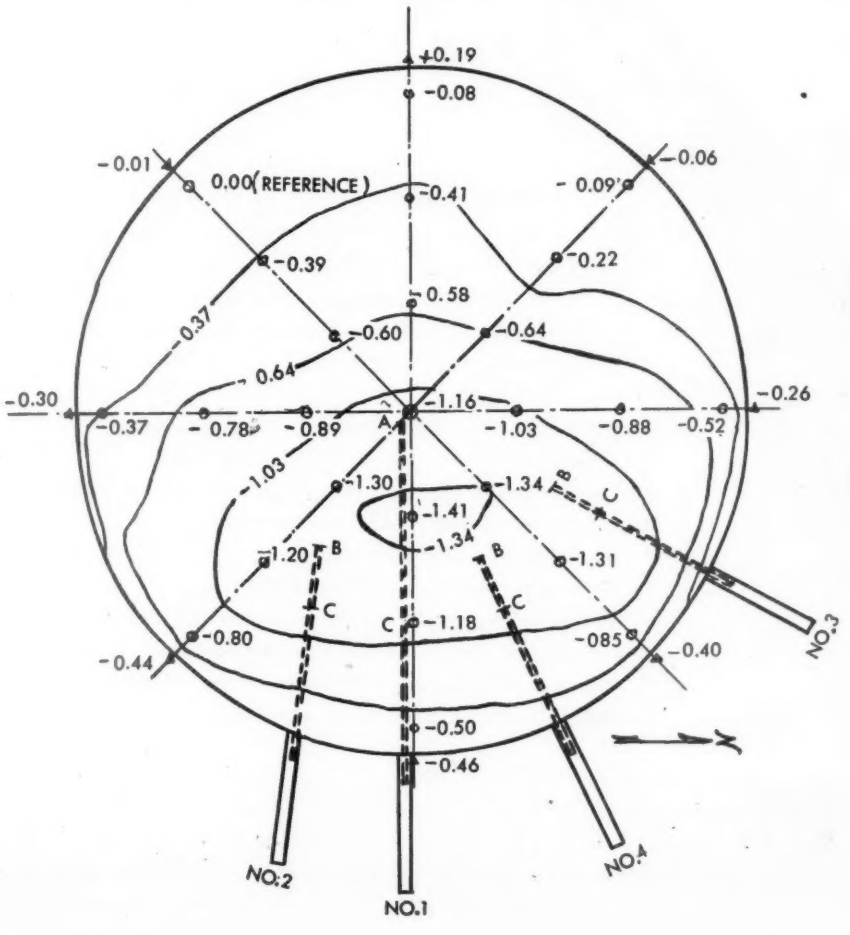
When the station and terminal were constructed in 1949, eight 81,000-bbl floating roof tanks were erected for crude oil service. These tanks are 110 ft in diameter by 48 ft high. The area where tanks were placed is traversed by several drainage ditches that were approximately 20 ft wide by 4 ft deep. An effort was made to avoid placing a tank over any of these ditches. In the case of one tank, MV-3, however, it was necessary to site the tank so that a ditch underlay a substantial portion of the east half of the tank. At the time the tank foundations were constructed the drainage ditch was filled with dry soil scraped from the adjacent area. The soil was placed in 6-in. lifts in a dry condition and was compacted by roading with a bulldozer.

The tanks were placed in service in mid-1950 and by the spring of 1951 all eight had settled to some degree. MV-3 had settled by far the most, the shell having lowered approximately 1 ft. The tank had settled reasonably uniformly and the tank structure itself exhibited no signs of distress. Under large dimension loads, however, it is customary for the center to settle more than the perimeter and the point was brought up that the bottom of this tank should be checked to see whether this was happening. To this end the tank bottom was sounded through the gauge hatch, the center drain, and the 26 roof support openings. These soundings indicated that a pocket existed in the tank bottom at approximately the location where the filled drainage ditch underlay the tank. With respect to the approximate 60-ft span the pocket was about 1 ft deep. The tank manufacturer advised that any increase in sag could cause considerable tension in the bottom plates with the strong possibility of rupturing them.

Consideration was given to: (1) Emptying the tank, floating it into one corner of the fire basin, building up the tank site to a new grade with select material, and refloating the tank onto the new grade; and (2) floating the tank away, piling the tank site, placing a concrete slab over the piling, and refloating the tank onto the slab.

Both considerations were rejected in favor of a relatively inexpensive experiment. Although the differential settlement that was localizing in one section under the tank bottom was considered objectionable, the uniform settlement of the tank as an entity was not felt to be particularly so. It was believed that the pocket in the bottom could be raised by inserting mud underneath the tank. This process is spoken of as mud jacking. It

FIG. 1. Elevations and contours developed prior to pumping operations. From this information it was ascertained where to insert the pipes through which the mud was pumped.
Note: Elevation in feet before mud pumping:
Point A is 53 ft in—Point B is 30 ft in—Point C is 20 ft in



*Staff Assisatnt, Mid-Valley Pipeline Company.

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is the same process whereby highway slabs and other concrete slabs are raised. In making its experiment, therefore, Mid-Valley merely took a page from the Louisiana Highway Department's book, so to speak, and adapted it to a petroleum problem, that body having had numerous pavement failures due to this same cause.

It was planned to insert the mud injection pipes underneath the bottom of the tank from points outside the shell. With this in mind arrangements were made with a mud pumping contractor of an imaginative turn of mind whereby he was to attempt to carry out this idea. The contractor, L. C. Pope of Vicksburg Machine Company, Vicksburg, Mississippi, had had some previous experience in raising concrete slabs by inserting the pipe from underneath rather than drilling through the concrete slab as is normally done. From this earlier experience he had developed a combined boring and jetting method of inserting the small 1¼-in. and 1½-in. pipe. This method consisted of rotating the pipe with an air rotary drill and simultaneously jetting through the pipe with water or a mixture of water and air. Three wings were welded at the drilling end of the pipe to give an upsetting effect so that the hole that was bored and jetted was larger than the pipe, thereby permitting the pipe to rotate and move freely as the hole became longer. When in operation it was possible for one man to shove the pipe under the tank. In this manner, entry pipe No. 2 (see Fig. 1) was inserted 53 ft in 30 min. Because the bottom of the tank had settled approximately 1 ft below the surrounding grade it was necessary to dig radial ditches extending from the shell outward, along the line the pipe was to be inserted, in order that the first 20 ft length of pipe could be begun underneath the tank bottom. As boring progressed, 20-ft lengths of threaded pipe were added. In two instances where the cutter wings struck the bottom of the tank it was immediately indicated by an audible noise. Boring was then stopped, the mud pump attached, and mud pumped through the pipe to raise the bottom of the tank off the cutter wings.

It was decided to use four or more sacks of Portland cement with each yard of dry soil. It was felt that the cement would serve two purposes: (1) It would absorb some of the moisture from the soil underneath the tank bottom by its hydration process, and (2) it would make the material, pumped under the tank to displace the bottom, dense and stable.

It was decided to raise the tank bottom while approximately 3½ to 4 ft of crude oil was still in the tank. This was desirable, for had the crude been removed from the tank the roof legs would not have all contacted the uneven bottom and hence the roof would have been poorly supported.

Immediately prior to starting the pumping operations the tank bottom was again sounded to develop the elevations

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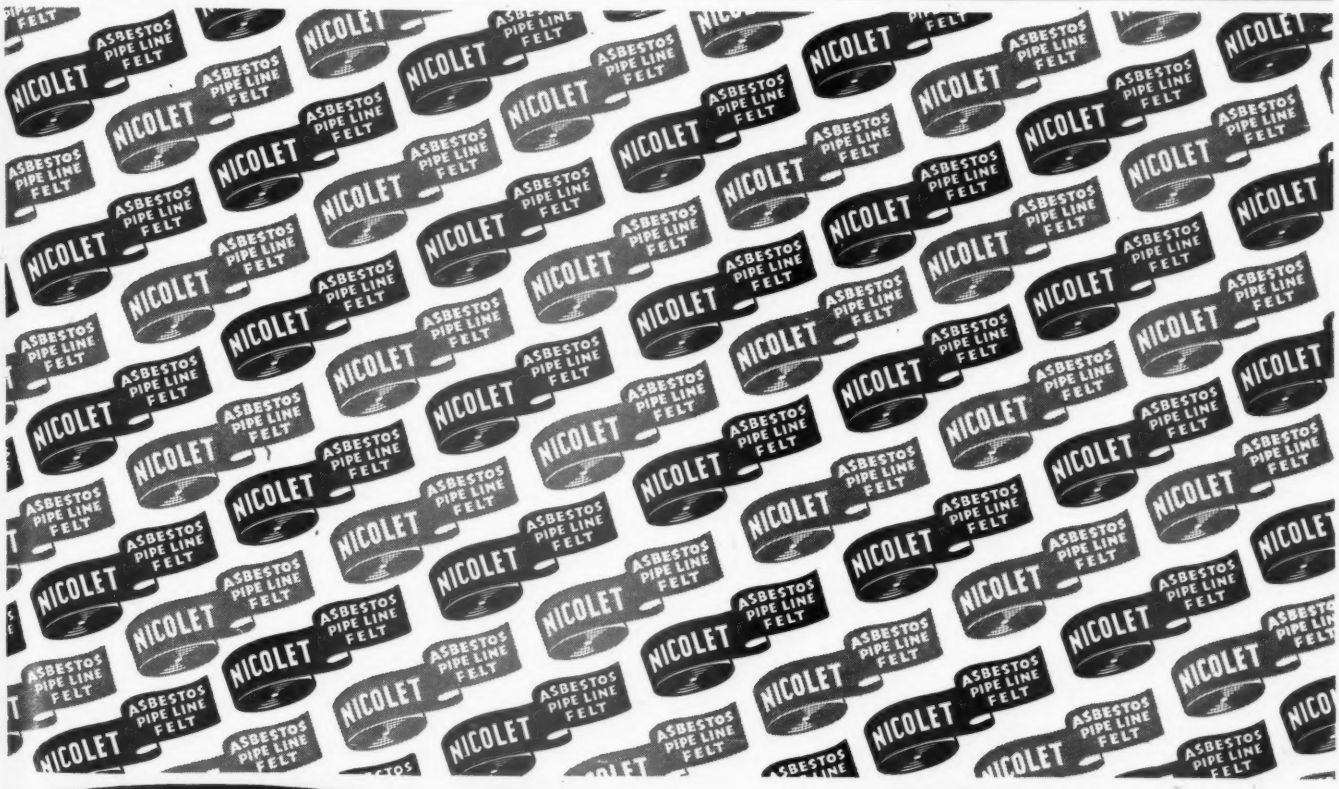

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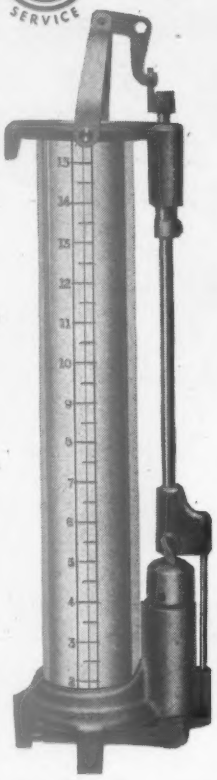

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and contours shown in Fig. 1. From the information indicated by the diagram it was ascertained where to insert the empty pipes.

The legs of the roof, which was in the floating position, were unpinned and allowed to rest on the bottom. The extent to which they protruded above the socket sleeves then was a gauge of the relative elevation of the points on the bottom. The contractor provided a mud pump that could handle 10 to 15 cu yd of mud per 8-hr day. It was planned in this instance to place approximately 80 cu yd of mud under the tank.

Mud was first injected as position A on No. 1 entry (Fig. 1). Pumping continued at this location until all legs had raised, which logic dictated should raise when mud was injected. The injection pipe was then pulled back to location B where the same procedure was carried out. Number 2, 3, and 4 entries were handled in the same manner, in each case the far position being pumped first so that it was a matter of pulling the pipe back rather than pushing it forward. There is no particular reason, however, why the pipe could not be shoved farther inward after pumping at any point. The entry pipes were pulled from their holes at the end of each work day and replaced the next morning if necessary. In the one instance when the pipe was not removed at the end of the day the soil froze around it during the night and it was virtually impossible to pull out.

One objection that can be raised to using the roof legs as gauges is the fact that they are too far apart, and there is no indication of what is transpiring between these points. It can be pointed out that there is a definite possibility of a serious localized dishing upward between the legs. A little thought, however, will indicate that the bottom is not going to deflect upward over a local area without developing substantial tensile stresses. These tensile stresses cannot develop unless the bottom is restrained from lifting at the edge of the upward bulge. There being no such restraint in this case it is logical to expect the bottom to come up in a reasonably uniform manner. After 90 yd of mud had been placed under the bottom, the entire bottom was at elevation 0.00 or higher. The maximum elevation was 0.68 ft. There were no abrupt changes in elevation in the bottom.

It is not the contention here that this procedure is in any way a solution to the problem of settlement of the entire structure due to soil consolidation. It is not. It is believed, however, that if some type of retainer were built around the full circumference of the tank it would be possible to raise the entire tank in this economical manner. Mud jacking does, however, provide a method of removing objectionable deep pockets in a tank bottom that have developed as a result of non-uniform settlement of soil.

The operation described here costs approximately $2000, or $25.00 per cu yd.

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Laurence H. Favrot, president of Houston Contracting Company, Houston, Texas, and president of Pipe Line Contractors.

E. J. Mahoney, Jr., president, Mahoney Contracting Company, Lansing, Michigan, is treasurer of organization.

Robert Thomas, president, River Construction Corporation, Fort Worth, Texas, is vice president of association.

Broad Scope to Program of Pipe Line Contractors

THOSE attending the fourth annual convention of the Pipe Line Contractors Association, Shamrock Hotel, Houston, Texas, January 8 and 9, will find the scope of the program broader, and, in all likelihood, a considerable increase in registration over previous years. This year, for the first time, contractors have invited their superintendents to the meeting and this should result in a boost in attendance of at least 100 over the 400 some odd present in 1951.

Also for the first time special entertainment is being provided for wives of members.

Officers and six new directors will be elected. Five directors, chosen a year ago for a two-year term, are held over.

The program, arranged under the able chairmanship of James P. Neill, president of Western Pipe Line Constructors, is as follows:

Tuesday, January 8

9:00 a.m.—Registration, lobby — The Shamrock.

10:30 a.m.—Meeting of board of directors.

12:00 noon—Luncheon—active and associate members, Shamrock Room, courtesy International Harvester Company.

2:00 p.m.—General meeting — active and associate members, Grecian Room.

1. Call to order—Laurence H. Favrot, president.
2. "One Hundred Ways to Save a Buck"—John W. Volpe, Volpe Construction Company, Malden, Mass.
3. Presentation of "Safety Manual for Pipe Line Construction"—Richard A. Gump.
4. "Taxation Affecting Pipe Line Contractors"—Iverson Walker, Carrington, Gowan, Johnson, and Walker, Dallas, Texas.
5. "Pipe Line Construction Practices"—J. C. Stirling, Service Pipe Line Company, Tulsa, Oklahoma.

6:00-7:30 p.m.—Cocktail party—active and associate members — Shamrock room, courtesy Caterpillar Tractor Co.

6:00-7:30 p.m.—Reception for ladies, Western Room, Cork Club.

Wednesday, January 9

9:30 a.m.—Meeting of contractors and their superintendents only, Castilian room.

1. Call to order—Laurence H. Favrot, president.
2. "Line Pipe"—Karl L. Fetters, assistant to vice president in charge of operations, Youngstown Sheet and Tube Company, Youngstown, Ohio.
3. Discussion of labor matters.

12:00 noon—Luncheon, active members only, Grecian Room, courtesy Caterpillar Tractor Company — "Outline for Construction Machinery"—an address by Harmon S. Eberhard, executive vice president, Caterpillar Tractor Company.

12:00 noon—Ladies Buffet Luncheon, Western Room, Cork Club.

2:00 p.m.—Meeting of contractors and superintendents only, Castilian Room.

1. Resume discussion of labor matters.
2. General business.
3. Election of officers and directors.
4. Adjournment.

5:30 to 7:00 p.m.—Cocktail party—active and associate members, Grecian Room, courtesy Thew Shovel Company.

7:00 p.m.—Annual banquet, active and associate members — The Emerald Room, "The Future of Pipelining"—an address by Gardiner Symonds, president, Tennessee Gas Transmission Company.

Directors and officers of association: Richard A. Gump, left, executive secretary; E. G. Morrison, Western Pipe Line Constructors, Inc., director; Clark Bledsoe, Midwestern Constructors, Inc., director; E. J. Mahoney, Jr., Mahoney Contracting Co., treasurer; T. A. Hester, Oklahoma Contracting Company, director; Ray L. Smith, Ray L. Smith & Son, Inc., director; L. H. Favrot, Houston Contracting Co., president; M. S. Williams, Anderson Bros. Corp., director; R. A. Conyes, Conyes Construction Corp., vice president; N. A. Saigh, N, A, Saigh Co., Inc., director; H. C. Price, H. C. Price Co., director. Not shown, Robert Thomas, vice president.

OLD . . . Bitumastic Enamel being applied by the "Sling Method."

NEW . . . Bitumastic Enamel being machine-applied.

PIPE-LINE PROTECTION IS *better than ever* WITH BITUMASTIC!

● BITUMASTIC has a remarkable history of corrosion-prevention, dating back nearly 100 years. And 50 years ago, Bitumastic Enamel "came into its own" for pipe-line protection.

But years ago it wasn't easy to apply protective coatings. For example, the "Sling Method" shown in the photograph on the left was used by many pipeliners. One man poured the hot enamel into the sling; two men "see-sawed" the sling up and down. Naturally this manual method was slow and laborious.

It's a different story today. Pipe lines are cleaned, primed, coated and wrapped mechanically. The coating machine, shown in the photograph on the right, applies Bitumastic quickly and evenly. Bitumastic is a better product, too. Improved formulation makes it easier to handle and apply.

Today, thousands of miles of the world's oil and gas pipe lines are effectively protected against corrosion by Bitumastic Enamel. Get the *same* effective protection by specifying Koppers Bitumastic Enamel for your next pipe-line project.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

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NEWS

New Oil Pipe Line Is Completed in Alberta

Totaling in cost about one-half million dollars, Alberta's latest completed oil pipe line, extending from the Joseph Lake sector to Edmonton, has been placed in operation. Between 2500 and 3000 bbl of crude, from Joseph Lake's 67 producing wells, are delivered daily to tankage at the Interprovincial terminal, east of Edmonton. The 24-mile outlet, built by the Edmonton Pipe Line Company, consists of 20 miles of 6-in. line from the southern end of the Lake to the southeast corner of Edmonton.

Construction work on another major pipe line in Alberta—the 52-mile gathering and transmission system connecting Wizard Lake with the new McColl-Frontenac refinery and the Interprovincial terminal at Edmonton—is expected to be completed shortly. Initial capacity of The Texas Pipe Line Company's systen will be 12,000 bbl of crude daily on gravity flow.

Two Wyoming Fields Are Connected to Service

Two additional oil fields in Wyoming, the Sage Springs Creek and the North Sage Springs Creek in Natrona County, have been connected to the Service Pipe Line Company's 12,000-mile transportation system.

A new pipe line, 23 miles of 8-in. pipe, has been built into the fields. It connects with a Service line now serving South Cole Creek in Converse County. From there the oil is pumped into the company's trunk system for delivery at such midwestern refinery centers as Kansas City, St. Louis, or Chicago.

Producers have been trucking their oil from both pools for the last two years.

Vaughn and Taylor Construction Company, Wichita Falls, Texas, was the contractor. Construction began in October, but work was held up by bad weather.

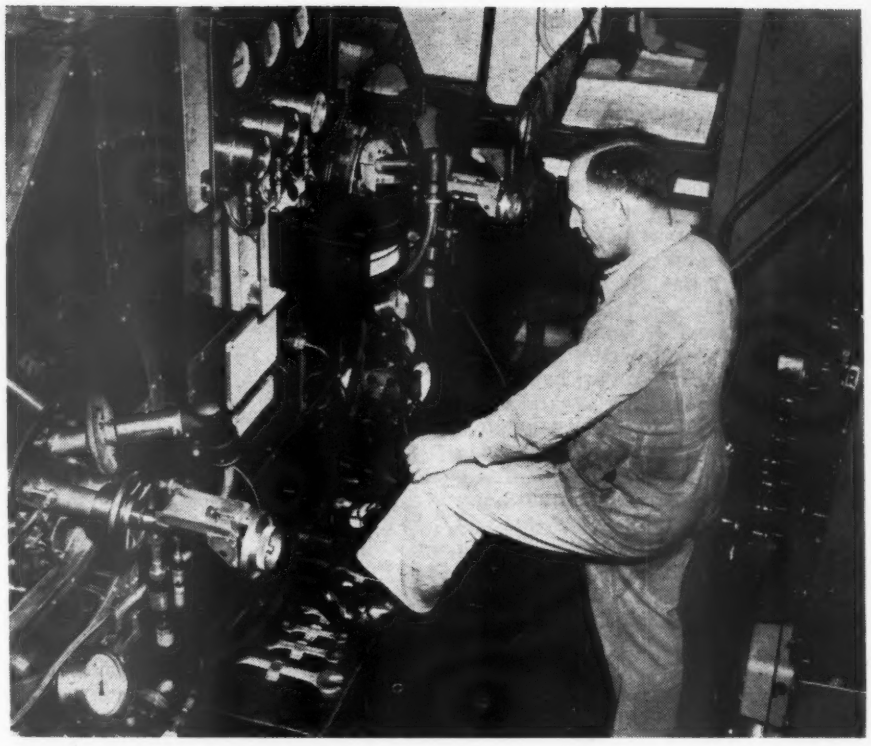
Pipe for the job was second hand and reconditioned. Most of it came from Texas. The project was approved by Petroleum Administration for Defense.

Smith Welding Equipment On Propane Storage Job

The O. R. Smith portable submerged arc-welding equipment is being used at Paola, Kansas, on a job to provide propane storage for the Phillips Pipe Line Company system. Pipe 30 in. in diam is being welded into 1000-ft sections and there will be 42 such sections. The sections or "vessels" will be laid underground approximately 12 in. apart, the ends capped, and valves installed.

A similar installation also will be made at Kankakee, Illinois, on the Phillips system.

Tetyak-Young, Inc., of Kansas City, Missouri, is the contractor. The O. R. Smith Company has its headquarters in Fort Worth, Texas.



Engine room of Shell's new gas turbine tanker.

World's First Gas Turbine Tanker in Regular Service

The world's first gas-turbine powered merchant ship—the 12,000-ton tanker *Auris*—has been put into regular service by Shell Oil Company. The *Auris* recently completed successful sea trials on a voyage to the Caribbean.

The tanker's new type engine is considered one of the most important recent developments in the shipping field. The gas turbine has only two moving parts. It is many tons lighter and requires considerably less space than ordinary engines of the same power, it is stated.

The *Auris*, built in England for one of the Shell group of companies, was specially designed for testing gas turbines, new types of cargo-handling equipment, and other improvements in marine design. Since her launching in 1947 she has been driven by four diesel electric units. One of these has now been removed to make way for the new gas turbine.

The *Auris* will continue in service as a regular oil carrier, according to the Shell spokesman.

New Service Line in Use in New Mexico

Larger runs of crude oil from New Mexico's Denton pool in Lea County are moving through a new Service Pipe Line Company line to Wasson, Texas, C. M. Scott, general manager, announces.

The new 25-mile, 10-in. discharge and gravity line connects with the company's West Texas trunk line and gathering system at Wasson, Scott said. The company formerly operated a 4-in. line from this area. Crosley and Hardy, Wichita Falls, Texas, were the contractors.

Texas Pipe Line Company Awards 250-Mile Contract

Contract has been awarded by The Texas Pipe Line Company to the Houston Contracting Corporation of Houston, Texas, for the construction of approximately 250 miles of pipe line from the South Louisiana area into the Texas Gulf Coast, it was announced by R. B. McLaughlin, president of the company.

The crude oil pipe line will consist of 220 miles of 22-in. from Houma, Louisiana, to Port Arthur, Texas, 28 miles of 12¾-in. from Houma to Cocodrie, Louisiana, and approximately 60 miles of gathering systems of 6, 8, and 10-in. pipe to serve Bay St. Elaine, Lake Barre, Lake Pelto, and Caillou Island oil fields in the Terrebonne Bay area of Louisiana.

It is anticipated that the first shipment of line pipe for this project will be received early in January, and actual field construction will begin immediately thereafter.

Phillips Looping Program Progressing Satisfactorily

The construction of 8, 10, and 12-in. loops to Phillips Pipe Line Company's existing 8-in. line between Borger, Texas, and East Chicago, Indiana, is progressing satisfactorily. Additional horsepower and facilities are being installed along the pipe line system whereby the additional pipe line mileage will be in balance for movement of petroleum products, including distillate, natural gasoline, motor fuels, and LPG. The unseasonable cold weather and excessive moisture have hindered construction.

J. L. Burke Again Heads Pipe Line Committee

J. L. Burke. Tulsa, president of Service Pipe Line Company. was re-elected chairman for 1952 of the Committee for Pipe Line Companies during the committee's annual meeting in New Orleans, December 14.

J. Howard Marshall, Ashland, Kentucky, president of the Ashland Pipe Line Company was elected vice chairman.

Re-elected were J. L. Seger, Shreveport, president of Interstate Oil Pipe Line Company, treasurer; Fayette B. Dow, Washington, D. C., general counsel, and Gordon C. Locke, Washington, D. C., executive secretary and associate general counsel.

The Committee for Pipe Line Companies is composed of representatives of common carrier crude oil and products pipe lines that report to the Interstate Commerce Commission.

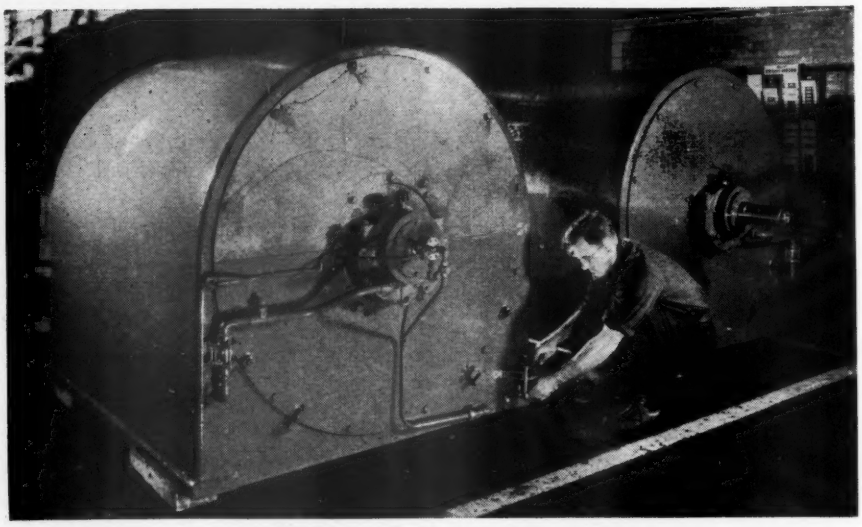
It was originally organized in 1945 for the purpose of gathering information and preparing a reply in response to the transportation inquiry conducted by the Committee on Interstate and Foreign Commerce of the House of Representatives under authority of House Resolution 318, 79th Congress.

The Committee was organized on a permanent basis in 1948 because of continuing requests for data and information with respect to petroleum pipe line operations.

Cramer New OPS Chief

Loring T. Cramer is the new chief of the Petroleum Branch, Transportation, Public Utilities and Fuels Division of the Office of Price Stabilization. He replaces O. D. Judd, who left OPS to accept a position with Sinclair Refining Company, in Washington, D. C.

Cramer has a broad background of experience in the petroleum industry, having spent 35 years in the marketing division of Continental Oil Company, Ponca City, Oklahoma. He retired from the position of assistant general sales manager in June, 1951, and has served as senior consultant for the firm since. His home is in Ponca City but he will reside in Washington while serving OPS.



Two 2500 hp, 4160 volt, 3580 rpm, type ANF, base ventilated squirrel cage induction motors.

Enclosed Forced-Ventilated Motors for Pipe Lines

An increasing number of multi-pump pipe line stations are reported installing Allis-Chalmers newly designed enclosed forced-ventilated motors. The motor has capsule-type bearings supported by split end shield, which permit easy interior access without exposing the bearings. They are equipped with two oil rings per bearing to assure uniform, uninterrupted lubrication. The supplementary forced-feed lubrication system used for 3600-rpm motors is self-contained and air cooled.

The motor is made for connection to air ducts in the foundation (as shown in the accompanying photograph) or for connecting at the top or sides. The motor's ventilating air is supplied under pressure and is discharged outside the motor room.

John L. Simpson Heads Bechtel Finance Committee

John L. Simpson has been elected chairman of the finance committee of Bechtel Corporation, San Francisco, California, it is announced by S. D. Bechtel, president of the company. Simpson has resigned as executive vice president of the J. Henry Schroder Banking Corporation and the Schroder Trust Company, New York, with which he has been connected since 1925, but will continue as a director of the two banking organizations.

Simpson has been a director of Bechtel Corporation since 1945. In addition, he has served as an officer or director of various domestic and international corporations, including chairman of the board, International Holdings, Ltd., and Hydro-Electric Securities Corporation.

A native Californian, Simpson was born in Woodland, graduated from the University of California with a B.L. degree in 1913, and was admitted to the California Bar. During World War I he served on various organizations headed by Herbert Hoover, including the Commission for Relief in Belgium; U. S. Food Administration, Paris; and American Relief Association, Central Europe and Yugoslavia.

In 1922 he became a research associate in the Food Research Institute of Stanford University before joining J. Henry Schroder Banking Corporation in 1925. He became a director of the latter in 1931 and executive vice president in 1936, maintaining headquarters in New York.

Simpson first became associated with the Bechtel interests early in World War II as a consultant on financial and corporate matters in connection with their shipbuilding, aircraft modification, and world-wide engineering and construction activities.

During World War II he also served for the Department of State as financial advisor to the chief of the economic section, Dr. Henry F. Grady, Allied Control Commission in Italy.

Simpson will make his headquarters in San Francisco.

☆ ☆ ☆

Two articles this month describe the new Texas-Illinois pipe line—one begins Page D-7 and one Page D-28.

Tulsa Three-Day Corrosion School to Be February 27-29

Plans have been made by the Tulsa Section NACE for a 3-day corrosion school to be held at the Mayo Hotel in Tulsa, February 27, 28, and 29. This school, for pipeliners, will be similar to those held the past two years.

Emphasis is to be placed on the purpose of the school; namely, that it is to be conducted on a non-technical basis for the expressed purpose of better acquainting field personnel with the "why and how" of corrosion control so they may participate more effectively in this phase of their company's operation.

The short course will be conducted on the basis of a series of discussion periods at the hotel and a field trip where a practical demonstration of the "why and how" of corrosion control can be made. This program will be conducted by pipe line men with broad experience in the mitigation of corrosion and will cover the following subjects: (1) Corrosion and its control; (2) rectifiers; (3) expendable anodes; (4) corrosion surveys; (5) use of pipe line locators; (6) use, care, and handling of instruments and equipment; (7) coating materials and application, and (8) installation and testing of insulating flanges and nipples.

Inquiries for additional information and registration forms should be addressed to Y. W. Titterington, Standard Magnesium Corporation, Box 1424, Tulsa, Oklahoma.

Wimberly Elected New FPC Vice Chairman

Commissioner Harrington Wimberly of Oklahoma, has been elected vice chairman of the Federal Power Commission to serve during the calendar year 1952. He will succeed Commissioner Thomas C. Buchanan who has served as vice chairman since May of 1950.

Wimberly is a graduate of the University of Oklahoma and has served as a member and president of its board of regents. Born at Hale Center, Texas, he resided in Hagerman, New Mexico, prior to entering the University of Oklahoma. Following his graduation from the University, he became advertising manager of the Altus (Oklahoma) Daily Times-Democrat. He became editor and publisher of the paper in 1929 and purchased it in 1936. From 1934 to 1936 Wimberly served as general manager of Oklahoma Newspapers, Inc., which published seven daily newspapers in western Oklahoma.

Commissioner Wimberly has been a member of the Federal Power Commission since October 5, 1945, and previously served as vice chairman for part of 1947 and all of 1948. He was director of the Southern Newspaper Publishers Association from 1940 through 1943, and director of the Oklahoma Press Association from 1935 to 1938. He served as president of that organization during 1937-38. Under provisions of the Federal Power Act, the commission each year selects one of its members to serve as vice chairman.

Texas Illinois Gas Line Is Dedicated at Joliet, Illinois

The new $135,000,000 Gulf Coast-to-Chicago pipe line of Texas Illinois Natural Gas Pipeline Company went into operation December 5 with dedication ceremonies at Joliet, Illinois, terminal of the 1417-mile project, and at Chicago. (For complete story on design and construction of the system, see article beginning on page D-7).

Natural gas drawn from six supply fields in the broad Gulf Coast region began flowing to Chicago and intermediate middle west markets in six states when a large valve outside the Texas Illinois metering station west of Joliet was opened. Initial capacity of the new line is 374,000,000 cu ft a day.

Principal participants in the turn-on ceremony were Oscar E. Hewitt, public works commissioner of the city of Chicago; Joseph J. Hedrick, president of Texas Illinois Natural Gas Pipeline Company; and James F. Oates, Jr., board chairman of Texas Illinois and chairman of The Peoples Gas Light and Coke Company, Chicago, and Mayor Martin H. Kennelly of Chicago.

Vice President Burlingame, President Hedrick, Mayor Kennelly, and Chairman Oates.

Mayor Kennelly turned the valve and Hewitt lighted a gas flare fed from the pipe line, marking the first utilization of the gas supply transmitted by the new 30-in. diam Texas Illinois line. More than 400 guests were present for the ceremony.

A dinner attended by 500 guests was held at the Blackstone Hotel, in Chicago, to observe the successful completion of the big four-state project. Among those present were leaders in the financial, business and professional life of the middle west, southwest, and east.

Hedrick, as toastmaster, praised the skill and efforts of Texas Illinois engineers and executives, as well as the contractors and material suppliers, whose work permitted completion of the project in approximately 15 months despite many obstacles. He said, "Testing of the line upon completion indicated that the pipe, engines and material used and the workmanship were unexcelled in the industry. Only seven minor imperfections were found after testing the line at 900-psi pressure."

Ground was broken on August 29, 1950, at Wharton, Texas, with Commissioner Hewitt turning the first spadeful of earth.

Oates, in his address, said: "We in the public utility business are proud to have completed this project. But we are primarily proud because it will serve the interest of the public by supplying daily human needs which have so much to do with the welfare and comfort of all.

"We are fortunate, indeed, in finding in our daily work a field of activity, a purpose of existence and the means of making our own lives count in the public interest for it is my conviction that all business must represent the public interest if it is to be successful.

"No thoughtful representative of management could honestly state anything else but that present day management not only does, as a matter of sound business philosophy, but must, as a matter of self-interest, represent the public interest in the America of today.

"Stated as briefly as possible, the basic aim of management is the attainment of the maximum of productivity so as to provide an uninterrupted and adequate flow of goods and services at reasonable prices, while at the same time paying employees fair wages, providing them with good working conditions, making provisions for research, expansion and replacement of properties, and paying reasonable returns to the people who have invested their savings in industry."

Oates termed the new pipe line, which extends from Falfurrias, Texas, close to the Rio Grande, to the Chicago region, "an economic tie of mutual benefit to both the peoples of Texas and Illinois."

Mark V. Burlingame, vice president in charge of operations of Texas Illinois, recounted the difficulties encountered in the line's construction. Among the most dismaying of these, he explained, were record-breaking rainfall and floods.

Plantation's New Line Opened with Ceremonies

Plantation Pipe Line Company, in December dedicated to the nation's industrial might a new $52,000,000 petroleum products pipe line, which will increase the company's fuel-delivery capacity in six southeastern states by 150 per cent.

The new 700-mile main between Baton Rouge, Louisiana, and Charlotte, North Carolina, was officially opened when Governor Herman Talmadge pressed a button that started a shipment of refined petroleum northward. In an address commemorating the event, Governor Talmadge said the new line was an important step in extending the South's economic and industrial horizons.

In his dedication address to an audience of 2500, Charles R. Younts, Plantation's president, traced the meteoric 10-year rise in demands for liquid fuels in the Southeast and its need for their economical transportation from Louisiana and Texas refineries to inland markets. Plantation's expansion program, which began last year, is tied to the "inevitable future growth of the South," and to the nation's industrial and defense needs, he said.

About 1000 guests, including federal and state officials, business men and educators, gathered at Bremen, Georgia, for the ceremonies, which also marked the 10th anniversary of Plantation's operations. Another 1000 guests and the company's 500 employees heard the event broadcast over a closed circuit linking Bremen with Plantation's headquarters in Atlanta and with 26 pipe line stations and terminals in its seven-state operations area.

Governor Herman Talmadge presses button that sends shipment of refined products through new line. Charles R. Younts, president of Plantation, gives an assist.

Following the opening ceremonies in a flag-bedecked tent adjoining the pump station, guests were conducted on a tour of Bremen's pumping facilities and tank farm. Plantation then played host at a barbecue lunch for the guests before their departure.

Bremen, 65 miles west of Atlanta, is a strategic pump station and delivery terminal on the new and original main lines, which extend from Baton Rouge to Greensboro, North Carolina. The new trunk line, which terminates at Charlotte, is a combination of pipe 18 in. and 14 in. in diam. The old line, which it parallels and supplements, is made up of 12-in. and 10-in. pipe.

Both mains connect with 8-in. and 4-in. branch lines, which carry products to markets off the main route that traces almost a straight line between the southern and northern terminals. The delivery capacity of Plantation's 1900-mile network will reach 10,000,000 gal a day early in 1952, Younts announced. This compares with the previous delivery rate of 4,000,000 gal a day—or an increase of 150 per cent.

The company's expansion program calls for construction of 10 additional storage tanks at Baton Rouge and 8 additional ones at Bremen—each to hold 55,000 bbl. The total tankage on Plantation's system will have a "working" storage capacity of 150,000,000 gal, the company president announced.

Completion of new pumping facilities along the new main line at 120-mile intervals is scheduled for early 1952, Younts said. The program also includes respacing of pumps along the system to 60-mile intervals. This part of the program will be completed by mid-1952.

By the future addition of pumping stations at 30-mile distance, he said, Plantation's delivery capacity can be boosted another 50 per cent.

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ECONOMICAL... Pewthers' EARTHRIPPER saves money three ways! It costs less—it's speedy operation saves labor costs . . . and standardization of automotive parts cuts down maintenance costs. Construction engineers who use the Pewthers' EARTHRIPPER have found that it costs only 4c a foot to operate. This low cost covers initial investment, depreciation, operation, maintenance, and labor over a three-year period! With an EARTHRIPPER, one man can handle your ditching problems, from driving the machine to the ditch site to lowering the boom and opening the earth at a maximum rate of twenty feet a minute! Because all gears run in oil, the EARTHRIPPER can be used for years with few replacements of parts. If you want to save time and money, invest in an EARTHRIPPER today.

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Pewthers' "EARTHRIPPER" is the only ditcher built into a truck. This means *one man* can handle your ditching job, from driving the machine to the ditch site to opening the earth to a maximum depth of five feet. The EARTHRIPPER is particularly suited for gas lines, extensions and house-to-street service lines. Utility ditching requiring ditches 10", 14", or 18" wide are duck soup to this new, *different* Pewthers' ditcher.

Send for the folder on the new Pewthers' ditcher, the EARTHRIPPER. Learn for yourself how the EARTHRIPPER can save time and money on any small ditching job! Ask for a demonstration before purchase . . . at any point in the United States!

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Service Moves District Headquarters to Stamford

Expanding oil production in Central West Texas has necessitated the Service Pipe Line Company moving its district headquarters to Stamford, R. R. McAnear, district superintendent, announced. The district office was operating on a temporary basis from Ranger.

McAnear and his staff will occupy space on the second floor of the Tayman Building. The offices have been remodeled and air-conditioned.

Until last spring, McAnear's headquarters were at Mexia. When the company expanded its facilities westward he set up the temporary office at Ranger. He moved his family to Stamford some months ago when the center of activity again shifted.

The company recently completed a 123-mile, 10-in. line from Bowie station, in Montague County, to Jud station in Haskell County. This line links crude oil production of Stonewall, Haskell, Knox, Throckmorton, Baylor, Archer, Young, and Clay counties to refineries of the midwest.

In addition, the company laid lateral lines from the Jud-Bowie line to Old Glory, Kiowa Peak, Aspermont, South Haskell, and North Knox City pools. Other expansion is planned.

Service also established a connection crew at Haskell to maintain these lines and lay new gathering lines as new oil production is brought in. H. A. Bayless is connection foreman of the 12-man crew. His crew and a small warehouse will occupy a building in Haskell.

Other personnel on McAnear's staff at Stamford are: B. D. Arrant, division clerk; W. A. Grimes, division gager; T. J. Adams, engineer; Mrs. Mary Webb, tender representative, and two stenographers not yet named.

FPC Issues Statistics On Gas Companies

The Federal Power Commission has released for distribution the 1950 edition of its annual publication "Statistics of Natural Gas Companies". The current edition reports the 1950 operations and the status at the end of the year of the 135 natural gas companies filing annual reports with the commission.

The publication contains, for 116 individual companies in classes A and B, detailed financial and operating information in the form of statements of the balance sheet, income and earned surplus acounts, gas operating revenues, customers, and sales, capital stock and long-term debt, gas operating expenses, gas utility plant investment, gas account, and data on physical property. Similar data, except those on capital stock and long-term debt, are shown in condensed form for 19 companies in classes C and D.

Companies in classes A and B are those having annual gas operating revenues in excess of $250,000 while companies in classes C and D are those having gas operating revenues in excess of $25,000 but less than $250,000.

Tight Tankship Market to Continue

Today's tight tankship market can be expected to continue for the next two years and may extend to 1957.

This prediction is made by Benedict Saurino, manager, Statistical Research Division, Sun Oil Company, in his tenth annual analysis of world tanker fleets.

Tied in directly with this tight market is the indication that tanker charter rates will continue at a high level, Saurino said.

His analysis shows that United States shipyards are lagging far behind those of other major nations in the building of tankships. Figures indicate that the United States is building or has on order less than a tenth of the business.

On the other hand, Great Britain has just less than half. Sweden and the Netherlands also lead the United States and western Germany now is building about the same as the U. S.

Saurino asserts that primarily responsible for this situation are the two factors of construction cost and operating cost differentials.

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PIPE LINE PERSONALS

▸ **Porter L. Howard,** general traffic manager of Sun Oil Company, retired December 31, Robert G. Dunlop, president of the company, announced. Howard has been active in the transportation and petroleum industries for more than 45 years. He completes 32 years' service with Sun, heading its traffic department during the last 21 years.

During World War II Howard spent more than two years in Washington as deputy director of the Liquid Transport Department of the Office of Defense Transportation, and later as director of that department. He continues to serve as a member of the shippers advisory committee of the Defense Transportation Administration.

▸ **I. B. Tietze** has been appointed general superintendent of the crude oil pipe line division of Phillips Pipe Line Company, subsidiary of Phillips Petroleum Company. Tietze continues as assistant to W. H. Wallace, vice president of Phillips Pipe Line Company.

Tietze graduated from the University of Missouri in 1926 with a degree of bachelor of science in civil engineering. Since joining Phillips in 1926, immediately following his graduation, Tietze has been engaged in pipe line construction and inspection, pipe line hydraulic and economic studies, and the protection of pipe lines from corrosion.

Tietze is a member of the American Society of Civil Engineers, National Association of Corrosion Engineers, API Sub-Committee on Internal Corrosion of Crude Oil Pipe Lines and Tanks, AGA Corrosion Committee, Veterans of Foreign Wars, and is a registered professional engineer of Oklahoma. He is the author of numerous technical papers.

▸ **W. Hale, Jr.,** has been promoted from district gager at Wasson, Texas, to district chief gager at Driver by Shell Pipe Line Corporation. **C. F. Oden,** district gager, has been transferred from Pardue to Denver City. **J. D. Pigman,** station chief engineer, formerly at Hamlin, is now at Westbrook. **F. W. Pollard** has been moved up from field gager at Wheeler-TXL to district gager at Pardue. **D. O. Waymire,** station chief engineer, has been transferred from Westbrook to Hamlin.

▸ **Dr. Norman Hackerman** of the University of Texas was the principal speaker at the December meeting of the North Texas Section of the National Association of Corrosion Engineers. His subject was "Recent Researches on Corrosion Inhibition". The meeting was held at the Cattlemen's Cafe in Fort Worth.

▸ **George Woelke** has been promoted to assistant compressor station superintendent at Ventura, Iowa, by Northern Natural Gas Company. Prior to his new assignment, Woelke was master mechanic at the Beatrice, Nebraska, station, a position he had held since 1950.

▸ **J. K. Alfred,** operations engineer, has been granted a leave of absence by Shell Pipe Line Corporation to permit him to serve in the Supply and Transport Division of the Petroleum Administration for Defense in Washington.

▸ **Frank E. Hanson,** superintendent engineer in the marine transportation department, Socony-Vacuum Oil Company, Inc., since 1946, retired December 31. He has been associated with the company for the last 30 years.

After serving as chief engineer on several tankers on the West and East Coasts, Hanson came ashore as machinery inspector for the company in 1923. In 1935 he was made port engineer and in 1943, assistant superintendent engineer.

Hanson is a member of Naval Architects and Marine Engineers Society and Port Engineers Association, New York.

▸ **Harold T. Williams,** 59, Northern Division superintendent of General Petroleum Corporation's pipe line department, died December 1, in Santa Barbara.

Williams, who was a native of Los Angeles, joined General Petroleum in May, 1921, as a roustabout. He spent his entire company career in pipe line operations in the Kern area.

Williams was a resident of Taft, California.

▸ **Thomas G. Rabbitt** will serve as general traffic manager of Sun Oil Company. He has had more than 34 years' experience in the Sun Oil traffic department. He had served as assistant general traffic manager since July of last year.

Joining the company as a traffic expediter in 1917, Rabbitt was on military leave during World War I and served in France with the 110th Infantry, 28th Division. He returned to Sun in 1919 and was engaged in various traffic and transportation duties until his appiontment as superintendent of tank car equipment in 1943.

R. B. McLaughlin

J. W. Emison

Pipe Line Group Promotes at Top Management Level

R. B. McLaughlin, president of The Texas Pipe Line Company, The Texas-Empire Pipe Line Company, and the Texas-New Mexico Pipe Line Company, has been elected to the newly created position of chairman of the board, effective January 1.

J. W. Emison is the new president of the three companies. He has been vice president and general manager of The Texas Pipe Line Company and the Texas-New Mexico Pipe Line Company, and vice president and assistant general manager of The Texas-Empire Pipe Line Company.

J. T. Rynd becomes vice president and general manager of the companies. He has been vice president and assistant general manager of Texas Pipe Line and Texas-New Mexico Pipe Line, and vice president of Texas-Empire.

L. F. Scherer, assistant general manager (construction and engineering), Texas Pipe Line and Texas-New Mexico Pipe Line, has been made a director of the two companies.

F. A. Stivers, vice president and general manager of Texas-Empire, vice president and assistant general manager of Texas Pipe Line and Texas-New Mexico, and a director of all three companies, has resigned all posts except that of director of Texas-Empire.

O. A. Newport, assistant general manager of Texas-Empire, becomes vice president and assistant general manager. C. H. Albitz, division manager of the oil traffic division of the same company, has been elevated to the position of assistant general manager (operations).

S. G. Kershner, assistant general manager of Texas-New Mexico, has been promoted to vice president.

McLaughlin started work for The Texas Company in 1906. When The Texas Pipe Line Company was organized in 1917 he became its assistant secretary. He was elected president and general manager in 1947. Emison began as a clerk with the company in 1920. He was elected vice president and assistant general manager in 1947. Rynd started work in the oil industry in 1908, and joined The Texas Company in 1913. He has served continuously since then in pipe line operations.

Stivers joined The Texas Company in 1917, and since 1928 has participated in the construction and operations of Texaco pipe lines.

"KARBATE" BRAND IMPERVIOUS GRAPHITE HEAT EXCHANGERS *FOR ALL PURPOSES!*

The "Karbate" impervious graphite heat exchangers illustrated are used extensively as boilers, coolers, condensers, vaporizers, evaporators, heaters and absorbers in handling corrosive chemicals, either hot or cold. They *all* can be had in a complete size range. *All of them* offer the following advantages:

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- **Immune to thermal shock.**
- **No contamination of product.**
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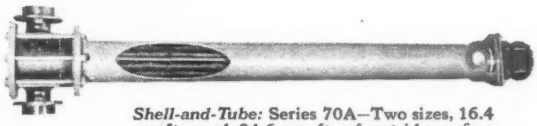
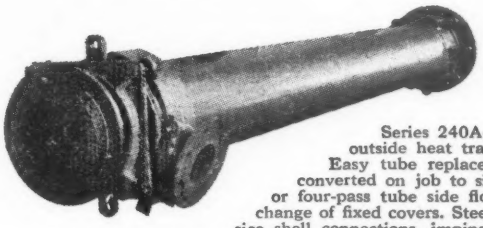


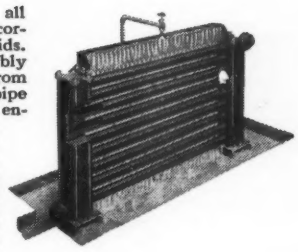
Shell-and-Tube: Series 70A—Two sizes, 16.4 sq. ft., and 24.6 sq. ft. of outside surface area respectively. Tubes easily replaced in the field. Interchangeable single and double-pass construction.

Style FH heat exchangers (Size 1½): Are especially recommended for tanks with solution depths of 16 inches or less. Write for catalog section S-6750.



Series 240A—70.6 feet of outside heat transfer surface. Easy tube replacement. Easily converted on job to single, double, or four-pass tube side flow by simple change of fixed covers. Steel, shell, oversize shell connections, impingement plates and drain and vent plugs integral with shell end castings. Stainless-steel baffles assembled with steel tie rods to form protective cage for tube bundle. Removable "Karbate" tube bundle. Write for catalog sections for S-6690, S-6715 for details of applications, maintenance, sizes and characteristics of these exchangers.

Cascade coolers: For all cooling jobs involving corrosive gases and liquids. Complete cooler assembly may be made quickly from 4 standard items in 5 pipe sizes. Capacity easily enlarged or reduced by adding or subtracting standard sections. Compact construction to save plant room. No special supporting structure needed. Write for catalog section S-6780.



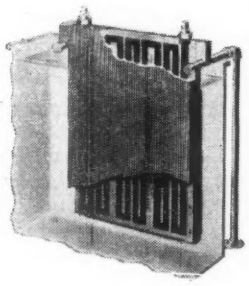
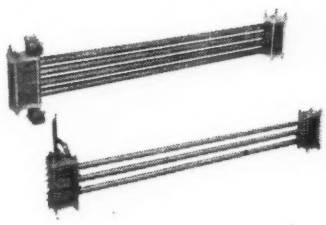


Plate heaters: Used to heat or cool corrosive liquids in tanks and vessels. Compact, completely assembled, easy to put in. Used in pickling, etching, plating and cleaning tanks. Complete size range. Models for horizontal and vertical mounting. Write for catalog section S-6620.



Concentric Tube exchangers: Available in two types. Series 10A is small, low-priced, gives true counterflow. Exceptionally good for small flow rates at narrow temperature differences . . . Series 20A manufactured with "Karbate" inner and outer piping, and is used to transfer heat between two corrosive fluids. Both have sectional construction, can be added to or subtracted from at will. Sturdy, can be moved from place to place after assembly, adapted to any method of mounting on floor, wall, or ceiling. Write for catalog section S-6670.

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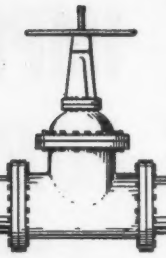
PIPE LINE PROJECTS



Texas Gas Subsidiaries Ask for FPC Authority

Two subsidiaries of Texas Gas Transmission Corporation have filed applications with the Federal Power Commission for authorization to operate pipe line facilities that would be used to make natural gas deliveries to their parent company in the North Tepetate gas field in Louisiana.

The applications were filed to comply with a Commission order issued November 6, which authorized Texas Gas to construct a 189-mile pipe line in Louisiana, with the condition that the new facilities could not be used for the transportation or sale of gas unless the two subsidiaries filed applications for FPC authorization for their facilities.

The subsidiaries are Texas Northern Gas Corporation and Louisiana Natural Gas Corporation, both of Lake Charles, Louisiana. Louisiana Natural's system includes approximately 165 miles of pipe line, all in Louisiana. The facilities of Texas Northern consist of about 38 miles of line and appurtenant equipment in Louisiana.

Texas Gas is proposing to purchase up to 46,800,000 cu ft of natural gas a day from Texas Northern and up to 93,200,000 cu ft a day from Louisiana Natural.

El Paso Given Green Light For Construction Program

The Federal Power Commission has issued an order making effective a presiding examiner's initial decision, which authorizes El Paso Natural Gas Company, of El Paso, Texas, to construct facilities to expand the capacity of its natural gas transmission system in the Southwest but denies an application by Nevada Natural Gas Pipe Line Company, of Las Vegas, Nevada, for authority to build a pipe line from Arizona to Nevada.

The examiner's decision authorizes two projects by El Paso. One is for the construction of facilities that would be used to make available an additional 100,000,000 cu ft of gas daily to present customers on its system in Texas, New Mexico, and Arizona. This construction program, estimated to cost $22,950,000, includes about 10.4 miles of 30-in. main line loop and 37,160 hp in new and existing main line compressor stations. The examiner found that certain other field and gathering facilities included in the project did not require FPC authorization.

The other El Paso project includes a construction program, estimated to cost $1,038,404, to increase the capacity of its facilities to serve the Phoenix, Chandler City, and Mesa, Arizona, area by 67,000,000 cu ft a day, making a total capacity of approximately 143,000,000 cu ft daily. Temporary authorization for these facilities was granted by the FPC in October, 1950.

The examiner denied Nevada Natural's proposed project because the company, he said, had failed to show the availability of natural gas for the service it proposed to render. Nevada Natural is seeking a supply of gas for the project from the El Paso system.

Nevada Natural's proposed project, estimated to cost $2,331,350, is a 114-mile pipe line for the transportation of natural gas for sale in Henderson, Boulder City, and Las Vegas, Nevada.

Atlantic Seaboard Plans 19,300 Additional Hp

Atlantic Seaboard Corporation, of Charleston, West Virginia, has applied to the Federal Power Commission for authority to construct and operate a total of 18,200 hp on its 26-in. main transmission line at four proposed new compressor stations and to install an additional 1100-hp unit at an existing station, all in West Virginia, to provide capacity to meet estimated maximum day requirements during the 1952-53 winter.

Atlantic said the proposed facilities would supply 89,500,000 cu ft of additional gas on a peak day. The company estimated the delivery capacity of its existing 26-in. line at about 258,200,000 cu ft. The proposed new facilities have an estimated cost of approximately $8,462,000.

The four new compressor stations would be built on Atlantic's Cobb (West Virginia)-Rockville (Maryland) 26-in. main line, in Braxton, Upshur, Pendleton, and Hardy counties, West Virginia. The additional 1100-hp unit would be installed at the company's Files Creek station in Randolph County.

Hearing Continued On Proposal to Remove Line

The Federal Power Commission hearing previously scheduled to begin December 12 in Washington, D. C., has been continued to February 13 in the proceedings on the application of Consolidated Gas Utilities Corporation, of Oklahoma City, Oklahoma, for authority to abandon and remove part of a natural gas pipe line that supplies the Clinton-Sherman Air Base near Clinton, Oklahoma. The postponement was requested by the company.

Texas Gas Asks For 407 Miles, 26,860 Hp

Texas Gas Transmission Corporation, of Owensboro, Kentucky, has applied to the Federal Power Commission for authority to construct natural gas pipe line facilities that are substantially the same as those which were denied by an FPC opinion and order issued November 6.

The commission's November 6 order authorized Texas Gas to build a 189-mile pipe line in Louisiana, but denied other proposals of the company, including plans to build about 404 miles of loop line on sections of its existing system between Bastrop, Louisiana, and Hardinsburg, Kentucky, together with about 17,260 hp of additional compressor capacity.

Texas Gas, in its new application, said that the only material changes are the elimination of the sale proposed to the Tennessee Valley Authority and the substitution of an interruptible sale of up to 45,000,000 cu ft a day to The Ohio Fuel Gas Company.

In lieu of the 404 miles of 26-in. partial loop previously requested, Texas Gas now seeks authority to build about 407 miles of the same size pipe. The new application includes plans for the installation of 26,860 hp instead of 17,260 hp as previously proposed.

Estimated total overall capital cost of the facilities as now proposed is $33,752,705.

Short Iowa Gas Line Given Final Approval

A Federal Power Commission examiner's initial decision, authorizing Iowa-Illinois Gas and Electric Company, of Davenport, Iowa, to build a 41-mile natural gas pipe line in Iowa to provide increased service to the Iowa City and Cedar Rapids areas, has become the final decision and order of the commission.

The examiner's decision was issued October 22, and as no exceptions were filed or review initiated by the commission, it became effective.

The new line, estimated to cost approximately $1,000,000, will parallel an existing lateral now serving the Iowa City and Cedar Rapids districts. The line will connect with the main line of Natural Gas Pipeline Company of America in Washington County, Iowa, and extend north to Cedar Rapids. Estimated capacity of the new line is 1,540,000 cu ft per hour and it will double Iowa-Illinois' capacity to serve the Cedar Rapids-Iowa City markets.

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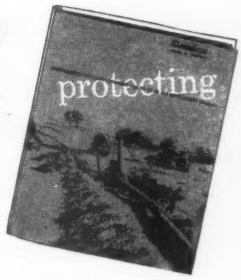

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Consolidated Hearing Scheduled for January

The Federal Power Commission has scheduled a consolidated hearing to begin January 28 in Washington, D. C., on applications by Transcontinental Gas Pipe Line Corporation, of Houston, Texas, and three subsidiaries of The Columbia Gas System, Inc., involving natural gas supplies on their respective pipe line systems.

The Columbia subsidiaries are Atlantic Seaboard Corporation and United Fuel Gas Company, both of Charleston, West Virginia, and The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania.

The proceedings include two applications by Seaboard—one for authority to construct interconnections with Transcontinental's system at Rockville, Maryland, and Ellicott City, Maryland, for the purpose of an exchange of natural gas between the companies, and the other for authority to sell gas to Pittsburgh and West Virginia Gas Company, of Pittsburgh.

Manufacturers are seeking authorization to construct an interconnection with Transcontinental's system in Chester County, Pennsylvania, and to acquire about 170 ft of pipe line and a meter station from the latter company. The facilities would be used for the exchange of natural gas between the two companies.

Transcontinental, in one application, is requesting authorization (1) for the exchange of gas with Seaboard and Manufacturers; (2) for the sale of the 170 ft of pipe line to Manufacturers, and (3) for the construction and operation of facilities at the interconnections with Manufacturers in Chester County, Pennsylvania, and with Seaboard at Rockville and Ellicott City, Maryland. Transcontinental subsequently amended this application by requesting that United be substituted for Seaboard for the receipt and exchange of gas from Transcontinental.

In a second application, Transcontinental is seeking authorization to sell gas to Seaboard and Manufacturers at the Rockville, Ellicott City, and Chester County interconnections. This application has been amended to substitute United for Seaboard as the purchaser of the gas.

The third proceeding involving Transcontinental relates to the disposition of 64,000,000 cu ft of natural gas a day, which was to be sold to Northeastern Gas Transmission Company for distribution in the New England area, as previously authorized by the FPC. Transcontinental originally proposed to begin this delivery on September 1, 1951, but recently advised the commission that it had terminated that contract and had suggested a new contract providing for deliveries to begin September 1, 1953.

The commission said that in view of this, Transcontinental apparently has a substantial volume of gas that may be used to alleviate the critical market shortages in areas adjacent to its system. The commission ordered the proceeding reopened for the purpose particularly of determining the disposition of this gas.

The January 28 hearing also will include an application by United, in which that company is seeking authorization for the exchange of natural gas with Transcontinental.

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Consolidated Proceedings Continued to January 16

The Federal Power Commission hearing previously scheduled for December 12 in Washington, D. C., has been continued to January 16 in the consolidated proceedings involving applications of West Texas Gas Company, of Lubbock, Texas, Southern Union Gas Company, of Dallas, Texas, and El Paso Natural Gas Company, of El Paso, Texas.

West Texas Gas Company is seeking FPC authority to construct new pipe line facilities in Potter and Randall counties, Texas, to increase the daily capacity of its natural gas system to about 135,000,000 cu ft. Southern Union is proposing to increase natural gas deliveries in the Clovis, New Mexico, area, whereas El Paso has asked the commission to permit it to reduce deliveries of gas to Southern Union's supplier, which is West Texas Gas Company.

The postponement was requested by counsel for West Texas Gas Company.

Columbia Gas System Hearings to Reopen

The Federal Power Commission has reopened a consolidated proceeding involving six natural gas applications and has scheduled further hearings to begin January 9 in Washington, D. C., to take additional evidence bearing upon the current estimated gas requirements and the gas supply situation of The Columbia Gas System, Inc.

Hearings on the six applications, in which all applicants propose to obtain their gas supplies from subsidiary companies of The Columbia Gas System, were held last April in Washington. The commission said that the facts relating to the gas requirements and gas supply situation of The Columbia System "have so changed since the hearing herein as to make it appropriate to reopen these proceedings."

The applications are by New River Gas Company, of Radford, Virginia, which is proposing to build a line to serve five cities in southwestern Virginia and is seeking gas from Atlantic Seaboard Corporation; Warwick Gas Corporation, of Florida, New York, and Crystal City Gas Company, of Corning, New York, which have asked the FPC to direct Home Gas Company to supply them with gas; Citizens Gas Company, of Stroudsburg, Pennsylvania, and Bangor Gas Company, of Bangor, Pennsylvania, which are seeking gas from The Manufacturers Light and Heat Company, and Pen Argyl Gas Company, of Pen Argyl, Pennsylvania, which would get gas indirectly from Manufacturers through a connection with Bangor Gas Company's system.

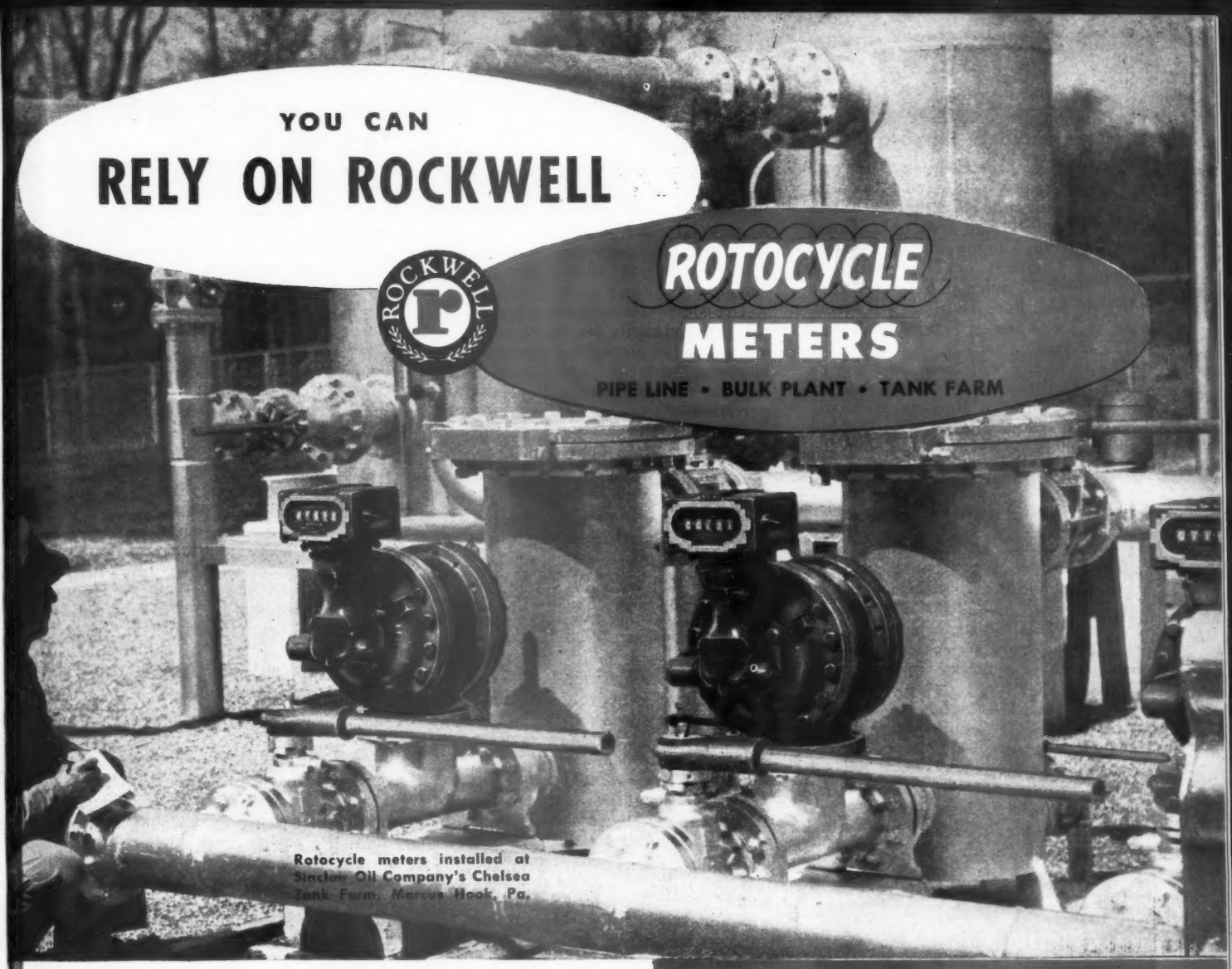
FPC Permits Tennessee Gas To Withdraw Application

The Federal Power Commission has granted a motion by Tennessee Gas Transmission Company, of Houston, Texas, to withdraw its application in which it was seeking authority to increase the capacity of its pipe line system by 115,000,000 cu ft of natural gas per day for ultimate delivery to markets in Ontario, Canada.

The commission permitted the withdrawal without prejudice to the company's filing, at a later date, an application for authority to build facilities to accomplish the same purposes.

Tennessee in its notice of withdrawal, said that the company is not prepared at this time to submit the exhibits required under the FPC's rules.

The proposed construction program covered by the application was estimated to cost $47,403,000. The project included a line extending from Buffalo, New York, to a point on the U. S.-Canadian border near Niagara Falls, New York. The 115,000,000 cu ft of gas was to be delivered to Niagara Gas Transmission Limited, a newly-formed Ontario corporation controlled by Consumers Gas Company of Toronto, for resale to Consumers for distribution in Toronto and for resale to other markets in Ontario.



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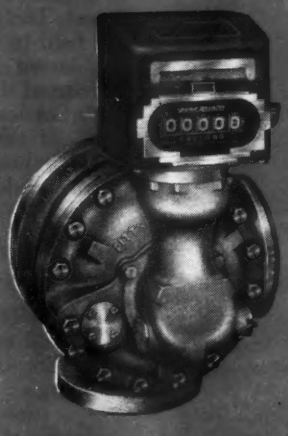

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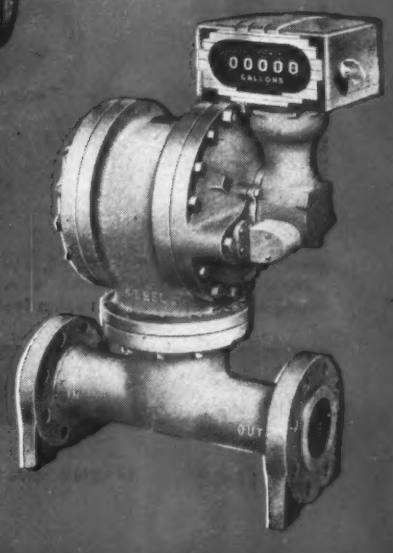

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Service Plans Gathering System in North Dakota

Service Pipe Line Company, a Standard Oil Company, of Indiana subsidiary, plans to lay a crude oil gathering system in the Beaver Lodge area near Tioga, North Dakota. Vaughn and Taylor Construction Company of Tulsa will construct about 12 miles of 6-in. and three miles of 4-in. line. The line will terminate at Tioga where Service will erect a 12-car loading rack.

The company will lease land for its loading facilities adjacent to a spur of the Great Northern Railway at Tioga. In addition to the rack, two 5000-bbl tanks are to be erected by Black, Sivalls and Bryson.

California Companies Permitted to Build

The Federal Power Commission has authorized Southern California Gas Company and Southern Counties Gas Company of California, both of Los Angeles, to construct and operate natural gas transmission facilities in the Los Angeles area.

The new facilities include a 23.5-mile, 30-in. pipe line extending from Inglewood to Los Angeles. The two companies would jointly own about half of the line, with the other half being owned solely by Southern California Gas Company. Estimated cost of the construction to Southern California will be approximately $2,288,169 and to Southern Counties, $323,706.

In addition, the commission authorized the companies to jointly operate an existing 15-mile section of 30-in. pipe line extending from Rivera Junction and Englewood, and authorized Southern California to operate an existing 3.9-mile section of 18-in. line in Los Angeles.

The companies propose to operate the facilities primarily for the movement of intra-state gas during the winter season; however, the facilities will be used during the summer months for the transportation of gas moving in interstate commerce.

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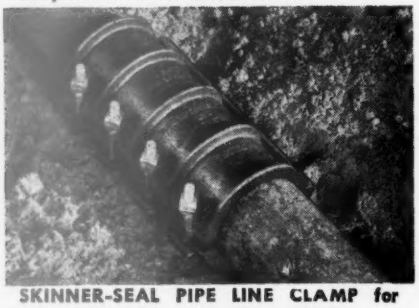

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Proposed Line Would Give Outlet to Two Gas Fields

United Gas Pipe Line Company of Shreveport, Louisiana, has applied to the Federal Power Commission for authority to construct an 11.3-mile pipe line in Terrebonne Parish, Louisiana, to obtain natural gas from two additional gas fields.

The proposed 20-in. line, estimated to cost $1,461,000, would connect with the company's main 24-in. line now under construction in Terrebonne Parish and would extend southwest to the Turtle Bayou and Kent Bayou gas fields. The line would have a capacity of 143,000,000 cu ft of natural gas a day.

The application says that at present there is no outlet for the gas produced in the two fields. The estimated total reserves of the two fields total approximately 490 billion cu ft, United said, with about 44,863,000,000 cu ft in place in the Kent Bayou field and 445,602,000,000 cu ft in the Turtle Bayou field.

Humble Laying Line to Ham-Gossett Field

The Humble Pipe Line Company is laying a 15-mile, 4-in. pipe line from the Ham-Gossett field near Athens, Texas. The line will extend south from the field to the Flag Lake area in west Henderson County, which is already connected to the Humble trunk system near Corsicana.

The Ham-Gossett field is now producing about 75,000 bbl of crude oil a month, which is being trucked to Flag Lake.

Texas-Empire to Expand Its System in Illinois

A project to modernize and expand the crude oil pipe line system of The Texas-Empire Pipe Line Company, from Wilmington, Illinois, to Lockport, Illinois, is announced by R. B. McLaughlin, chairman of the board of directors.

Approval has been obtained from the Petroleum Administration for Defense, the company disclosed, and a contract will be awarded for the construction of 30 miles of 18-in. pipe line between Wilmington and Lockport, Illinois.

It is anticipated that the pipe for this project will be received and that actual construction will be undertaken about August 1, 1952.

California Companies to Construct Gas Lines

The Federal Power Commission has authorized Southern California Gas Company, of Los Angeles, and Pacific Gas and Electric Company, of San Francisco, to construct natural gas pipe line facilities to provide service in the Antelope Valley of southern California.

The FPC order authorized Southern California Gas Company to build a 38-mile line extending from a proposed connection with Pacific Gas and Electric's system near Mojave, California, to the communities of Mojave, Lancaster, Palmdale, and Rosamond in the Antelope Valley. The project will supply natural gas to Mojave, Lancaster, and Palmdale, now served with liquid petroleum gas, and to Rosamond, which has no gas service at present.

Pacific Gas was authorized to build a line tap and metering and regulating facilities in its line near Mojave, to deliver gas to Southern California Gas Company in exchange for gas that the latter company will deliver to Pacific Gas at its Kettleman Hills, California, compressor station.

Proposed Canadian Line Would Cost $82,000,000

Premier Byron Johnson said the Trans-Mountain Oil Pipe Line Company proposes to build an $82,000,000, 693-mile oil pipe line from Alberta through British Columbia by way of the Yellowhead Pass to Burnaby, a Vancouver suburb. It is subject to approval by the Board of Transport Commissioners.

Initial capacity of the line will be 75,000 bbl a day but it can be increased to 200,000 bbl a day.

Financing of the project has been underwritten by Imperial Oil Ltd., Standard Oil of B.C. Ltd., Shell Oil of Canada Ltd., Canadian Gulf Oil Company, Ltd., Union Oil of California, Richfield Oil, and S. D. Bechtel and Associates.

Proposes 22-Mile Natural Gas Line

The Federal Power Commission will hold a hearing beginning January 9 in Washington, D. C., on the application of Rockland Light and Power Company, of Nyack, New York, for authority to build 22 miles of natural gas transmission line from Orangetown to Tomkins Cove, New York.

Rockland also is seeking a commission order directing Transcontinental Gas Pipe Line Corporation, of Houston, Texas, to establish a connection with the proposed line at Orangetown and to provide a supply of natural gas to meet the requirements of Rockland's eastern division. The eastern division includes Nyack, Upper Nyack, South Nyack, Grand View on Hudson, Piermont, and parts of Orangetown and Clarkstown.

Rockland's proposed new line is estimated to cost about $753,315 and would have a daily capacity of approximately 11,000,000 cu ft of natural gas.

With the PIPE LINE CONTRACTORS

Jayhawk Construction Company, Inc., P. O. Box 68, Great Bend, Kansas, began work December 13 on 13.5 miles of 12-in. pipe line for Kaw Pipe Line Company. The section is between Gorham and Susank, Kansas. On December 4 work got underway on 16 miles of 4 and 6-in. line near Ellis, Kansas, for Service Pipe Line Company.

H. B. Zachry Company, P. O. Box 2570, San Antonio, Texas, completed the middle of December, 83 miles of 30-in. pipe line for Texas Eastern Transmission Corporation, extending from Columbia to Lafayette, Tennessee.

Cheek Construction Company, P. O. Box 491, Ulysses, Kansas, is laying a gathering system in the Hugoton field for the Cities Service Gas Company. The system consists of 101 miles of pipe in sizes ranging from 6 in. through 22 in.

Altgelt Construction Company, P. O. Box 1402, Corpus Christi, Texas, is laying 30 miles of 12-in. for Western Natural Gas Company, from the St. Charles field, Aransas County, Texas, to Corpus Christi. Lee Phillips is the superintendent.

Conyes Construction Corporation, 2884 San Pablo Avenue, San Pablo, California, expects to complete about the first of the year the 117 miles of 22-in. being laid for Ohio Oil Company. The section is from Sheridan, Indiana, to Lima, Ohio. The field office is at Elwood, Indiana. M. A. Norwood is superintendent.

Parkhill Truck Company, P. O. Box 1856, Tulsa, Oklahoma, has the following work under way:

47 miles of 12-in. for Phillips Pipe Line Company, from Hardtner, to Wichita, Kansas; contractor, G. G. Griffis Construction Corporation. H. C. Peterson, foreman.

122 miles of 8-in. for Standard Oil Company, (Indiana) from Neodesha, Kansas, to Sugar Creek, Missouri. Harold Deatherage, foreman.

94 miles of 20, 24, and 26-in. for United Gas Pipe Line Company, from Port Neches to Houston, Texas; contractor, River Construction Corporation. R. M. Hiser, foreman.

26 miles of 20-in. for Ohio Fuel Gas Company, from Xenia to South Solon, Ohio; contractor, Sheehan Pipe Line Construction Company. Ira Gould, foreman.

25 miles of 6 and 8-in. for Indiana Gas and Water Company, in the vicinity of Crawfordsville, Indiana; contractor, L. W. Tarnow; foreman, A. L. Hill.

150 miles of 30-in. for Texas Eastern Transmission Corporation, from Wheelersburg to Powhatan Point, Ohio, and 66 miles from Uniontown, Pennsylvania, to Moundsville, West Virginia; contractor, Anderson Brothers Corporation; foremen, Ray Herron and Jimmis Stubblefield.

125 miles of 30-in. line for United Gas Pipe Line Company, from Louisiana-Mississippi State line to Jackson, Mississippi; contractor, River Construction Corporation; foreman, Charles Sampson.

10 miles of 24 and 26-in. for The Texas Company in the vicinity of Salem, Indiana; contractor, Midwestern Constructors, Inc.; foreman, O. C. York.

19 miles of 6 and 8-in. for Michigan-Wisconsin Pipe Line Company from Fort Atkinson to Janesville, Wisconsin; contractor, Sheehan Pipe Line Construction Company; foreman, Ira Gould.

Mahoney Contracting Company, 2300 North Grand Avenue, Lansing, Michigan, is finishing up the 100 miles of 30-in. it has had underway for Texas Eastern Transmission Corporation, from Ford, Kentucky, to Portsmouth, Ohio. The field office is at Vanceburg, Kentucky. Henry Mogg is superintendent and Frank Parts assistant. Joe Cuthbert is office manager.

For Michigan Gas Storage Company, 95 miles of loops are being laid from Laingsburg to Mt. Clemens, Michigan. Pipe sizes are 8, 12, 16, 20, 22, and 24-in. The field office is at Clarkston. Barney Finnerty is superintendent, Mike Finnerty assistant, and Al McConnell office manager.

Work is going forward on the water crossings of the Gulf of Coro and Lake Maracaibo in Venezuela for Shell Caribbean Petroleum Company. The Coro crossing consists of a single 4-mile, 30-in. line. The Lake Maracaibo crossing is double 20-in. lines each 5 miles in length. Angelo Tavernaro is in charge.

Trojan Construction Company, 1416½ North Robinson, Oklahoma City, Oklahoma, likely will complete sometime in January the 50 miles of 30-in. being laid for Texas Eastern Transmission Corporation between Ford and Moorhead, Kentucky. The field office is at the latter point, Charles T. "Swede" Tillotson is superintendent and Walter Wells office manager.

The contractor has recently completed 40 miles of 10-in. for Phillips Pipe Line Company between Bay, Missouri, and California, Missouri.

Reese Brothers Construction Company, Hugoton, Kansas, is installing a 181-mile gathering system for Northern Natural Gas Company, consisting of 4, 6, and 8-in. pipe. The system will be in parts of Texas County, Oklahoma, and Kearney, Finney, Haskell, Seward, and Morton counties in Kansas. Paul G. Reese and Gale Reese are superintendents, Edd Reese spreadman and Chet Beighle office manager.

Comstock Midwestern, Ltd., 206 Laird Drive, Leaside, Ontario, Canada, is laying 210 miles of 10 and 12-in. products pipe line from Sarnia to Toronto, Canada, for Imperial Oil, Ltd. The work is scheduled for completion in the spring. The field office is at Strathroy, Ontario. Denver Franklin is superintendent, J. A. Kippan assistant superintendent, and E. C. McFadden office manager.

Associated Pipe Line Contractors, Inc., 3272 Westheimer Road, Houston, Texas, is constructing approximately 100 miles of pipe line for United Gas Pipe Line Company between Napoleonville, Louisiana, and the New Orleans area. The pipe is of 20, 24, 26, and 30-in. diam. The field office is at Morgan City. L. H. Gray is superintendent and Ralph Herwig office manager.

This contractor is making ten water crossings for Gulf Oil Corporation between Texas City and Orange, Texas. One is of the Houston Ship Channel, the others are river and bayou crossings. W. A. Briley is in charge of the work and R. N. Cain is taking care of the field office, which is in Dickinson.

Somerville Construction Company, Ada, Michigan is laying 66 miles of 8 and 10-in. for Michigan Gas Utilities Company from Coldwater to Hillsdale, Michigan. The field office is in Coldwater. Jim Godwin is superintendent and R. B. Wagner office manager.

Ray L. Smith and Son, Inc., Hazlett Building, El Dorado, Kansas, is working four spreads on a job for Socony-Vacuum Oil Company, Inc., White Eagle Division, involving the take-up, reconditioning, and relaying of 175 miles of 6-in. products line between Augusta, and Kansas City. Spreads are:

El Dorado, Kansas: Dewey Whitworth, superintendent, and Don Marley, office manager.

Burlingame, Kansas: Carl Colvin, superintendent, and Berne Seagle, office manager.

Topeka, Kansas: Clark Ligett, superintendent, and John Salisbury, office manager.

Tonganoxie, Kansas: George Keppler, superintendent, and Carl Smith, office manager.

Gulf Southern Contractors; 516½ Louisiana Avenue, Shreveport, Louisiana, have the overall contract to lay approximately 1000 miles of pipe for the United Gas Pipe Line Company in Louisiana, Texas, and Mississippi. Gulf Southern is a contracting group consisting of River Construction Corporation, Fort Worth, Texas; Oklahoma Contracting Company, Dallas, Texas; J. Ray McDermott and Company, New Orleans, Louisiana, and Morrison-Knudsen Company, Inc., Boise, Idaho.

Smith-Donaho Contracting Company, 205 Northwest Seventh Street, Fort Worth, Texas, is unloading pipe and will begin work January 1 on two 10-in. loops, totaling 41 miles, for Phillips Pipe Line Company. The work is between Paola, Kansas, and Warrensburg, Missouri. This is a part of Phillips' looping program on its products line. The field office is at Warrensburg, with Herb Smith superintendent, H. E. Doyle, spreadman, and Ernest Bell office manager.

Oklahoma Contracting Company, 6512 Hines Boulevard, Dallas, Texas, had 21 miles to go on the 86-mile section of 30-in. being laid for United Gas Pipe Line Company from Pierce Junction to Refugio. Field headquarters are at Victoria with Raymond Law the superintendent.

For the same company, 100 miles of 30-in. pipe is being laid from the Colorado River, near Wharton, to Refugio, by a spread under "Panama" Shiflett. Headquarters are at El Campo.

Between Refugio and Agua Dulce, 53 miles of 24-in. pipe will be laid by Ed Flannagan and his crew beginning about the middle of January. The field office will be at Sinton.

River Construction Corporation, P. O. Box 9127, Fort Worth, Texas, is working two spreads on the 90 miles of 20, 24, and 26-in. for United Gas Pipe Line Company between Orange and Houston, Texas. "Banty" Traweek and "Borger Red" McMenamy are the spread foremen. B. C. "Barney" Hall is general superintendent. Q. B. Davis, Jr., is office manager. All crews are working out of the field office at 3000 Commerce Street, Port Arthur.

A total of 255 miles of 20, 24, and 30-in. pipe is being laid for United between Napoleonville Junction, Louisiana, and Kosciusko, Mississippi. "Red" Tatom's spread is now making its headquarters at Jackson, Mississippi, and is laying the section from the Pearl River crossing south of Jackson to the Pearl River crossing north of Jackson. Merle Tatom's spread has its headquarters at Hazelhurst, Mississippi, and is laying toward the Pearl River to the point where Red's spread began work.

Jimmy Reid's spread is laying 20-in. from Week's Island to Bayou Sale and 12-in. from Lafayette to Week's Island. Headquarters are at Jeanerette. When the 20-in. is completed, the field office will be moved to Canton, Mississippi, and pipe will be laid south from Kosciusko until a junction is made with Red Tatom's crew. This work will start right after the first of the year.

Eastern Pipe Line Contractors, 1801 Mercantile Bank Building, Dallas, Texas, has completed its job for Texas Eastern Transmission Corporation, consisting of 51 miles of 30-in. in Alabama and Tennessee. Last field headquarters were at Lawrenceburg, Tennessee, with J. H. Schumacher, Jr., superintendent and Fred Harwell and J. D. Jones in the office.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, began a job in December for Southern Union Gas Company consisting of 30 miles of 20-in. in the vicinity of Farmington, New Mexico. The field office is at that point with Jerry Nash in charge.

Meanwhile progress on the Platte Pipe Line Company system advances as rapidly as receipt of pipe permits. The field office at this time is at Wheatland, Wyoming, with A. A. Carrigan the superintendent and D. G. Wagner office manager. Fulton's part of the Platte system is 433 miles between Casper, Wyoming, and Brule, Nebraska.

Williams Bros.-Davis Co., 6006 Jensen Drive, Houston, Texas, is laying 165 miles of 30-in. pipe line for the Texas Eastern Transmission Corporation, from Koscuisko, Mississippi, to Florence, Alabama. The field office is at Red Bay, Alabama. G. R. Hamilton is superintendent and Jimmy Jester, office manager.

Bishop and Lock Construction Company, 1018 Magnolia Building, Dallas, Texas, will lay 142 miles of the Platte Pipe Line Company system when pipe is available. The section is from Marysville, Kansas, to Holdrege, Nebraska.

Oman Construction Company, Inc., Box 146, Nashville, Tennessee, has the prime contract to lay 79.5 miles of 30-in. on the Texas Eastern Transmission Corporation system, from Columbia, Kentucky, to Hartville, Tennessee. Part of the job has been contracted to Anderson Brothers Corporation.

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, is laying pipe between Salisbury, Missouri, and Wood River, Illinois, on the Platte Pipe Line Company system. Overall, the contractor will construct 280 miles of the system, from the Missouri River near St. Joseph, Missouri, to Wood River. The field office is in the Greer Building at Mexico, Missouri. The superintendent's office and warehouse are at Troy, Missouri. M. C. Johnson is superintendent and Howard Smith office manager.

Also for Platte, 12-in. and 20-in. crossings are being made of the Mississippi River near Hartford, Illinois. R. W. Jernigan is superintendent of this work and J. A. McCord foreman.

Burden recently contracted to lay 154 miles of 24-in. for Sinclair Pipe Line Company between Drumright, Oklahoma, and Humboldt, Kansas. One spread is working out of Yale, Oklahoma, with Floyd Lewis the superintendent and Ben Mapes office manager. A second spread has its headquarters at Independence, Kansas. A. B. Haynes is superintendent and Walter Hill office manager.

Williams Brothers Company, National Bank of Tulsa Building, Tulsa, Oklahoma, has contracted to install three river crossings for Texas Eastern Transmission Corporation. These are the Hocking, Muskingum, Monongahela, and Ohio.

The foreign division of Williams Brothers is laying two lines in Venezuela. For Shell Caribbean Petroleum Company, 160 miles of 30-in. are being laid from Palmerejo, near Maracaibo, to Punta Cardon.

For the Venezuelan Atlantic Transmission Corporation, 195 miles of 10, 12, and 16-in. pipe is being laid from Las Mercedes to Caracas. This is a gas line. Marvin Jones, with headquarters in Caracas, is in charge of both jobs.

Western Pipe Line Constructors, Inc., Lockhart Building, Austin, Texas, has two spreads at work on Texas Eastern Transmission Corporation's new construction. One spread has its headquarters at Tompkinsville, Kentucky, the other at Danville, Kentucky. W. B. Williams and Jack Hodges are the superintendents.

Sheehan Pipe Line Construction Company, 529 National Bank of Tulsa Building, Tulsa, Oklahoma, is engaged in laying 25 miles of 20-in. pipe line for Ohio Fuel Gas Company in the vicinity of Xenia. The field office is at that point with Red Williams in charge.

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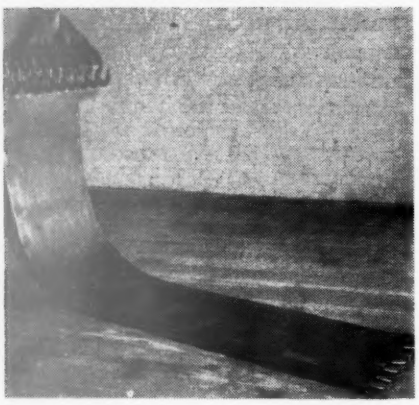

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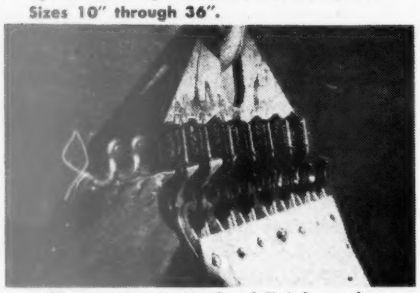

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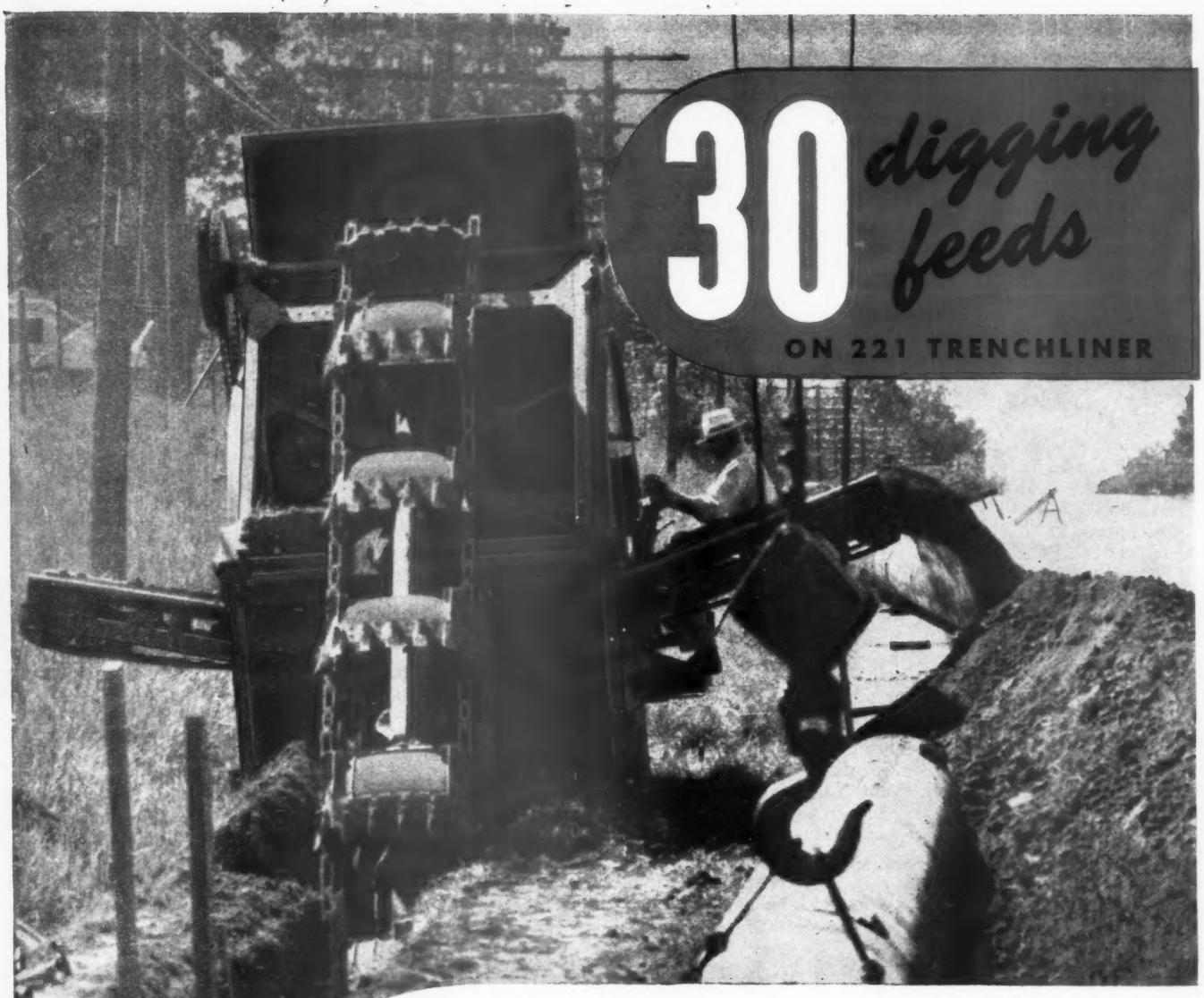

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Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has the following work under contract:

Approximately 181 miles of 26-in. gas line for Texas Gas Transmission Corporation from the vicinity of Bastrop, Louisiana, south to the vicinity of Eunice, Louisiana. This work is being done by three spreads as follows:

North spread starting near Beekman, Louisiana, and laying approximately 65 miles south to the vicinity of Grayson, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office; headquarters, Monroe, Louisiana.

Center spread starting at header on the north side of the Red River near Pineville, Louisiana, and laying approximately 60 miles north to the vicinity of Grayson, Louisiana. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, office; headquarters, Olla, Louisiana.

South spread starting at header on south side of the Red River and laying approximately 56 miles south to Tepetate field near Eunice, Louisiana. F. A. Silar, superintendent; C. V. Oliver, assistant superintendent; L. F. Redfearn, office; headquarters, Eunice, Louisiana.

Approximately 140 miles of 12-in., 8-in. and 6-in. lay and take up for Interstate Oil Pipe Line Company in the vicinity of New Iberia and Franklin, Louisiana. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. C. MacWhinnie, office; headquarters, Franklin, Louisiana.

G. G. Griffis Construction Company, 2514½ East 15th Street, Tulsa, Oklahoma, is laying 210 miles of 26-in. loops for Northern Natural Gas Company in Kansas, Oklahoma, Texas, and Nebraska. The field office is at Great Bend, Kansas. G. L. Mims is general superintendent, E. G. Grisham, spreadman, and Mont Wood, office manager.

Bills and Troth Construction Company, Wright Building, Tulsa, Oklahoma, expects to complete, the early part of 1952, the 122 miles of 8-in. line being laid for Standard Oil Company of Indiana from Neodesha to Belton, Kansas. Carl Bills is superintendent.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa 3, Oklahoma, has completed and tied in one of three 20-in. lines being installed under the Mississippi River near Wittenberg, Missouri, for the Texas Illinois Natural Gas Pipeline Company. Work is progressing on the other two lines. The field office for the job is at Grand Tower, Illinois. Howard S. Lipp is coordinator, Feiday Davis superintendent in charge of pipe, and Ivan Steele office manager.

At the Tuscola, Illinois and Edgerton, Indiana, stations of Panhandle Eastern Pipe Line Company, two new units are being installed. At both places the work was 55 per cent completed the middle of December. H. H. Voss is in charge of the Tuscola office and K. L. Kreamalmyer is superintendent at Edgerton.

In Marion County, Illinois, 31,250 ft of 26-in. and 21,300 ft of 24-in. pipe is being laid for The Texas Company. John Work is superintendent and N. Boies manager of the office at Salem.

The installation of mud, water, and gas lines for Aluminum Ore Company continues at Bauxite, Arkansas. Earl S. Powell is superintendent, Bill Daniels, Eldon Rolfe, and F. C. Snavely area superintendents, and Morris Garey office manager.

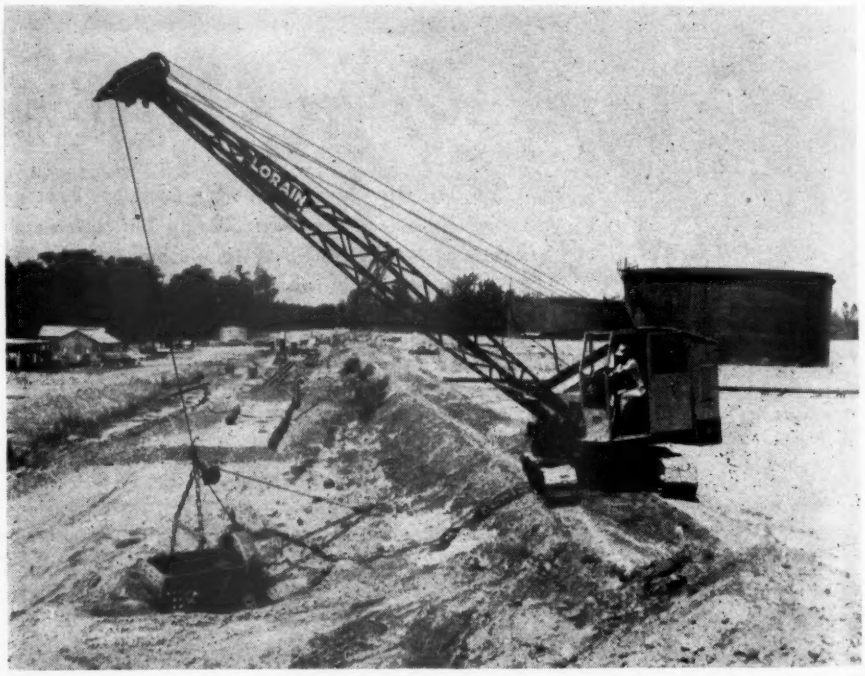
Brown-Lite Company, 135 North Sheridan, Tulsa, Oklahoma, is laying a total of 68 miles of 10-in. loops for Phillips Pipe Line Company between El Dorado and Osawatomie, Kansas. Headquarters are at the latter point, with R. E. Carriker, superintendent; Bill Houseman, assistant superintendent, and Harold Lee in charge of the office.

Anderson Brothers Corporation, 707 North Drennan Street, Houston, Texas, has been awarded contracts for three "jobs" by Texas Eastern Transmission Corporation, totaling 217 miles and extending from the Ohio River near Portsmouth, Ohio, to Connellsville, Pennsylvania. Job No. 8 extends from the north side of the Ohio River 77 miles to a point near Amesville, Ohio. Job No. 9 is from the latter point 74 miles to the Ohio-West Virginia crossing of the Ohio River. Job No. 10 extends from the second crossing of the Ohio River to a point near Connellsville, a distance of 66 miles. The pipe is 30 in. in diam. Additionally, 25 miles of 30-in. has been subcontracted from Oman Construction Company, Tennessee, 35 miles of 30-in. from N. A. Saigh, Kentucky, and 30 miles of 30-in. in Tennessee.

On the Algonquin Gas Transmission Company project, approximately 95 miles of 24-in. pipe is being laid from Hartford, Connecticut, to Boston, Massachusetts. One spread has its field headquarters at Mendon, Massachusetts, where J. F. Whitlow is superintendent. Another has its offices at Putnam, Connecticut, Earl Saulsman is superintendent; Frank Hindman office manager.

Modern Welding Company, Inc., Box 528, Owensboro, Kentucky, is installing a complete gas system for the city of Gallatin, Tennessee, which totals 36 miles of ¾-in. through 10-in. The address at Gallatin is P. O. Box 60, the telephone number 1510. A. J. "Blackie" Anderson is superintendent, Billy Spencer, material man; F. M. "Slim" Hoagaland, stringing foreman; Mac McKelvey, ditch; Wes Embry and Hastings Embry, welding foremen; Charlie Miller, dope; Horace Fuqua, tie-in; Harry Pryor, chief inspector. Barnard and Burk of Baton Rouge, Louisiana, are engineers for the project. The kick-off was October 11.

N. A. Saigh Company, Inc., Suite 531 Majestic Building, San Antonio, Texas, is completing 80 miles of 30-in. on the Texas Eastern Transmission Corporation system. The section is from Columbia, Tennessee, to Boonsboro, Kentucky. The field office is at Danville, Kentucky. Carl Doyle is superintendent, Raymond Doyle spreadman, Dike Kenslow assistant spreadman, and James E. Gray office manager.



Building Fire Wall Around Tank Farm. A Lorain-TL dragline, owned by Brooks and Droddy of Eldorado, Texas, and working for Gasoline Plant Construction Company, Houston and Corpus Christi, builds a fire wall around a tank farm 5 miles north of Eldorado. The farm, consisting of nine 93,000-bbl tanks, is owned by the Triangle Pipe Line Company of Shreveport, Louisiana, and required a dike 10 ft high and 8100 ft long to contain it.

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NEWS

Oil Industry Can Request Price Raise Under OPS Law

The recently passed Office of Price Stabilization General Overriding Regulation 21 applies to the production of crude oil as well as to refined products, OPS has announced. As a result, oil producers may apply for individual price raises to cover increased production costs between the 1950 base period and July 26, 1951. It was estimated that the increase in ceilings available by applications to the OPS would amount to about 13 per cent.

When the Overriding Regulation 21 first came out it was believed directed only at manufacturers, as the oil industry is not mentioned, however, in a press release issued the same day, OPS officials announced that the amendment applied to the oil industry as well.

Operators will calculate their new ceilings by adding or substracting from their base-period price the increase or decreases in costs of material, labor, etc., between their base date and last July 26. Five different forms must be filled out and submitted to OPS. PAD Administrator Brown reported that "In determining the procedure under which a correct amount of increase may be granted, the method of determining costs as set out in the regulation is clearly not applicable to crude oil." Conferences are being held with the OPS and industry representatives at this time, however, to establish a suitable method of arriving at these costs.

More Hearings to Be Held On California Tidelands

Latest development in the long legal fight between California and the Supreme Court is the latter's call for further hearings to determine what parts of the oil lands off the coast of California are under U. S. control and what parts are controlled by the state. A special master has been instructed to recommend answers to three questions that must be answered before it is decided whether the state or the federal government will control the under-water lands involved. William H. Davis, special master, suggested the questions last May and they present such problems as whether water areas between the mainland and offshore islands are to be considered "inland waters".

Celenese Creates New Firm

The Celenese Corporation of America has created a new subsidiary, Petrocel Corporation, which has opened geological offices in Corpus Christi, Texas. The new corporation is an exploration and development company, and is reported to have been formed as a step in a long-range program to augment Celanese's supply of oil and gas used as raw materials in its chemical, textile, and plastics operations.

New Study to Be Made Of Coal Hydrogenation

Secretary of the Interior Oscar L. Chapman has approved a request of the Bureau of Mines to have an independent organization undertake studies to assist in determining acceptable engineering and financial bases for estimating the cost of synthetic liquid fuel products of commercial-size coal hydrogenation plants.

Under Secretary Chapman's approval, Robert E. Rose, assistant secretary, is authorized to contract with Ebasco Services, Inc., of New York, for an engineering audit and an independent evaluation of portions of the Bureau of Mines report entitled "Cost Estimate for Coal Hydrogenation." Ebasco plans to obtain the services of Dr. Charles O. Brown, New York City consultant.

Recently, the National Petroleum Council completed a study made at the invitation of Secretary Chapman on the cost of producing liquid fuels from oil shale and from coal. While the results of this study were in reasonable agreement with the Bureau of Mines estimates on the cost of producing liquid fuels from oil shale, the N.P.C. estimates were substantially higher than the figures determined by the Bureau for producing liquid fuels from coal by the coal hydrogenation process.

The decision of the Bureau of Mines to seek an independent check of its figures was reached before the NPC reported its estimates on October 31.

Total Oil Imports Down

Total oil imports of crude and petroleum products fell 101,900 bbl daily in the week ending December 8, from a week earlier totaling 751,000 bbl a day, the American Petroleum Institute has reported. Main reason for the drop was a 101,700-bbl-a-day drop in heavy fuel oil imports to an average of 335,900 bbl. Crude petroleum shipments to this country were up 11,300 bbl daily from the preceeding week.

The following table includes figures on imports of crude and residual oil as set out by the API:

Week ended	Crude Oil	Residual Oil	Total Products	Total
November 17	454,600	363,300	18,600	836,500
November 24	498,100	235,800	9,100	743,000
December 1	393,900	437,600	21,400	852,900
December 8	405,200	335,900	9,900	751,000
4 week av	437,900	343,200	14,700	795,800

Oil Demand Rise Seen

An increase of 5 per cent has been estimated in total demand of all oil for 1952 by the Bureau of Mines. The estimate followed a 9.7 per cent increase in 1951 when the average was 7,463,000 bbl daily. It predicted a 29 per cent decline in exports this year, with an increase of about 7 per cent in domestic demand. Exports averaged 427,000 bbl daily last year—a gain of 40 per cent over the previous year. Total imports are expected to raise 8 per cent in 1952, with the average for last year set at 846,000 bbl daily.

IOCC Survey Reveals That Two-Thirds Wells Strippers

According to the Interstate Oil Compact Commission's Stripper Well Survey, approximately 68.7 per cent of the 467,776 wells producing in the nation as of January 1, 1951, may be classified as stripper wells. In 1950 these wells produced 375,551,037 bbl, or 19 per cent of the total amount.

The survey, which is published in booklet form, is made annually. It began in World War II because of price problems that arose at that time. The survey is especially significant at the present time as the Office of Price Stabilization is offering a subsidy to take care of prices in stripper areas where ceilings once again have worked hardships.

Representatives of the Pennsylvania Grade Crude Oil Association, heart of a large stripper area, recently asked OPS for permission to lift the ceiling on Penn Grade crude and let it find its own price level. Spokesmen for other stripper producers asked for the same action, but OPS offered a subsidy instead.

PAD Looks for Scrap Steel

In granting priorities aid to new oil and gas projects, the Petroleum Administration for Defense has announced that it will seek assurances that scrap from replaced equipment will be made available to scrap dealers. PAD Administrator Brown stated that although the PAD had always given priorities assistance on a determination of how essential a project was, but now it had to consider what the project may be able to contribute to the collection of needed scrap.

Steel Output Rise Seen

The oil industry is asking for a total of 2,141,988 tons of steel for the second-quarter 1952 domestic oil and gas operations. The Petroleum Administration for Defense estimates that 47,030 tons of steel will be required for Canadian and 225,899 tons for other foreign operations.

Deputy Administrator Burce K. Brown, anticipating an increase in production of steel by the third quarter of next year, has set a minimum of 45,000 wells for 1952 and believes 46,000 is possible.

Iraq Well Pleased with New Oil Royalties Deal

In a speech which opened the Iraqi parliament recently, Prince Ziad, reading the speech for Prince Regent Abdul Ilah pointed with satisfaction at the "manifold increase in royalties" to be paid by the Iraq Petroleum Company to the government under a new agreement. Prince Zaid, who broadly outlined government policy in his speech, referred to a new agreement reached in mid-August between the government and the partially American-owned company, with which Iraq obtains 50 per cent share of the profits.

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Brown Urges Development Of Western Hemisphere Oil

A study of the oil industry in Western Hemisphere nations and the exchange of ideas obtained from such a study should encourage the full development of petroleum resources by each Western Hemisphere country without injury to the welfare of any nation.

This view was expressed by Russell B. Brown, general counsel, Independent Petroleum Association of America, in an address before the West Central Texas Oil and Gas Association in Abilene recently.

The Western Hemisphere oil study committee of IPAA is the result of the need felt by the Association for such a study, added Brown.

"A strong domestic industry provides the first line of defense against any aggression that threatens our country and supplys an immediate source of available petroleum products for such countries as may be allied with us in the defense of ideals essential to world peace," pointed out Brown.

Our second line of defense, we have been told, Brown added, "is provided through the ability of other countries of the Western Hemisphere to maintain for their own use and available to us, supplemental petroleum supplies that may be used not only for their own armed forces, but be available to supplement our own supply when needed."

Italy to Receive Aid From International Bank

The Italian Minister for Foreign Trade has announced that negotiations have begun between Italy and the International Bank for Reconstruction and Development for loans that will aid oil development in that country. One loan will enable the Italian government to finance the Azienda Generale Italiana Petroli (AGIP) in the Po Valley in regard to oil and gas exploration and development and constructing of gas lines.

In Central Italy, according to a report from Enrico Mattei, vice chairman of AGIP, a drilling rig capable of reaching 3500 metres is being used in the Morrovalle zone in the Chienti Valley (Abruzzi). Mattei also reported that a credit of 200,000,000 lire has been allowed to finance the drilling.

Raffineria Siciliana Industria Olii Minerali (RASIOM) of Palermo, has applied for permission to raise crude oil processing capacity of its Augusta refinery to 800,000 tons a year. Anonima Petroli Italiana (API) of Rome, has applied for a permit to increase its Falconara refinery from 350,000 to 700,000 tons a year.

Joins Rinehart

R. P. Brooks, formerly oil editor of the *Shreveport Journal* and *Dallas Times Herald*, has joined the editorial staff of the Rinehart Oil News Company. Rinehart has been publishing oil reports and information for 26 years.

June Oil Output Under May Production Total

The first occurrence in 1951 of a month's daily average crude petroleum production dropping below that of the previous month took place during June when the world's average daily production of 11,937,000 bbl represented a decrease of 38,000 from the May level. Declines in daily average production in Iran, the United States, and Qatar, more than offset record daily crude production in Kuwait, Saudi Arabia, and Canada. For the quarter ending June 30, world crude production averaged 11,863,000 bbl daily compared with 11,373,000 during the first quarter of the year. Crude production during the first six months averaged 11,619,000 bbl daily, an increase of 19 per cent over the same period of 1950.

Western Europe's daily average imports of crude petroleum increased 44,000 bbl to 1,105,000 bbl in June. The major importing countries in barrels daily were: United Kingdom, a record 332,000 (May 321,000); France 380,000 (316,000); Italy and Trieste, 157,000 (159,000); Netherlands, 115,000 (136,000); and Western Germany, 67,000 (90,000). Crude petroleum imports into the United Kingdom and France for the first 6 months of 1951 as compared with the same period of 1950 were 49 per cent and 26 per cent higher respectively.

Film Depicts Operations In West Texas Oil Area

A motion picture, covering the unusual operations in West Texas described in the July issue of *The Petroleum Engineer*, was shown to a group of oil men in Dallas, Texas, recently. The film, which is shown by Wilshire Oil Company, is technicolor and in sound. It is available for showings to higher grade schools, colleges, business clubs, civic groups, and indeed, wherever it would seem that it might help to enlighten the public as to the ways of the petroleum industry.

McCarthy Expects to Buy Into Egyptian Oil Company

Back in the U. S. after an extensive trip to Europe, Glenn McCarthy, Houston, Texas, oil man, expressed the belief the Egyptian Government would soon enact legislation enabling him to buy into National Petroleum Company of Egypt. He plans to begin exploratory work in that country as soon as the proper legislation gives him permission.

The National Petroleum Company of Egypt is a private firm that holds permits on approximately 21 exploration blocks in Egypt. Dr. S. De Lazovery, announced from Cairo recently that he, McCarthy, and a Swiss financial firm, Hofman Bank of Zurich, had formed a syndicate and agreed in principal to buy 51 per cent of the stock of the Egyptian company. He added that the agreement depends on revision of the Egyptian law, which requires that Egyptians holds 51 per cent of the stock.

PAD Asks Oil Output Raise Among Free Nations

The Petroleum Administration for Defense has announced that it will encourage a 9 per cent increase in crude oil production among the free nations outside of the United States. Present output of these nations is approximately 4,600,000 bbl daily, and PAD has asked that this be increased to 5,000,000. In return, it has promised them the necessary steel for drilling new wells, expanding refinery capacity, and building new pipe lines.

The schedule calls for new drilling programs in: Canada, 2000; Venezuela, 1424; Mexico, 482; Peru, 275; Argentina, 246; and the rest of the Western Hemisphere, 464. The Middle East has been slated for 153, India and Pakistan, 52; Africa, 4, and Ethiopia, 2. The Far East has been set for 274, and Europe 67.

The proposed 1952 program also calls for operation of foreign refineries at 4,400,000 bbl a day, nearly 479,000 bbl above this year's daily refinery runs.

Colorado Field Ordered To Conserve Natural Gas

Unless voluntary gas conservation is taken immediately, the Colorado Oil and Gas Conservation Commission will take action in the Rangely oil field, Warwick M. Downing, chairman has reported. He added, "Rangely has produced 25 per cent of its gas, and the rest has got to be conserved."

Speaking before a hearing on proposed rules and regulations for Rangely field, Downing reported that the commission had postponed stepping into the situation in the hope that the oil industry would do something. The Commission wants something done about injection of non-flared gas into the Weber.

At the present time both The Texas Company and The California Company are carrying on gas-injection operations and are returning about 3,000,000 cu ft of gas to the Weber sand. The Commission wants the operators to return all gas to the producing Weber reservoir. The California Company has proposed that the Commission establish a limiting gas-oil ratio of 1000 cu ft of gas per barrel of oil.

Sinclair Opens New Research Laboratory

Sinclair Oil Corporation has announced plans to open laboratory facilities in Tulsa, Oklahoma, as a part of its program to expand its research activities in petroleum production and exploration.

The Tulsa project will be housed in two company-owned buildings that are being altered and air-conditioned for the purpose, P. C. Spencer, president, has announced. Raymond M. Carr will manage the project, which will be operated by Sinclair's subsidiary Sinclair Research Laboratories, Inc., in conjunction with its extensive research testing and shop equipment at Harvey, Illinois.

PEPA ELECTS OFFICERS AT ITS 28TH ANNUAL MEETING

PEPA 1952 board of directors elected at the association's annual meeting are: Seated, Fred B. Clark, Arkansas Power and Light Company, El Dorado, Arkansas; W. L. Pearson, Southwestern Public Service Company, Lubbock, Texas; O. J. Frandsen, Public Service Company of Oklahoma, Tulsa, Oklahoma; J. W. Lambert, Southwestern Public Service Company, Borger, Texas; T. E. Graham, Oklahoma Gas and Electric Company, Oklahoma City, Oklahoma. Standing, R. N. Crossman, Jr., Houston Light and Power Company, Houston, Texas; W. M. Larkin, Gulf States Utilities Company, Lake Charles, Louisiana; J. E. Moody, Southwestern Gas and Electric Company, Shreveport, Louisiana; D. S. Coffman, Texas Power and Light Company, Dallas, Texas; Ned W. Beaudreau, Central Power and Light Company, Corpus Christi.

The Petroleum Electric Power Association held its 23rd annual meeting at the Shamrock Hotel, Houston, Texas, recently. New officers were elected and many important papers presented.

F. M. Austin, vice president, Houston Lighting and Power Company gave the opening address, "Welcome to Houston." He was followed by Ernestine Adams, The Petroleum Engineer, Dallas, Texas, whose speech was titled, "The Multi-Billion Dollar Spoof." W. S. Morris, vice president and general manager, East Texas Salt Water Disposal Company, Kilgore, discussed the "Disposal of Salt Water in the East Texas Oil Field."

On the second day of the meeting, H. H. Anderson, vice president Shell Pipeline Company, Houston, Texas, spoke on "Why Power Companies should promote Corrosion Control." Hugh Stewart, head of mechanical engineering subdivision, Humble Oil and Refining Company, discussed "Electrical Power in Oil Refining." This was followed by "The Economics of Water Flooding in Texas' Oldest Commercial Field" by W. S. Guthrie, vice president, Coffield-Guthrie, Inc., Corsicana.

The last two speeches delivered in the afternoon were "Operational Advantages in the Use of Electric Power for Pumping Oil Wells," by A. S. Ross, vice president, Caddo Oil Company, Inc., Shreveport; and "Distribution and Control of Power for Oil Field Pumping," by C. R. Olsen, Westinghouse Electric Corporation, East Pittsburgh.

Below—Retiring president, R. E. Patrick, Kansas Gas and Electric Company, Wichita, Kansas, shakes hands with T. E. Graham, left. In the center are J. E. Moody, secretary-treasurer, and Ned W. Beaudreau, vice president.

Above—T. E. Graham, new president, congratulates Ernestine Adams, *The Petroleum Engineer*, on her talk at the meeting. Onlookers are Lee Riley, Kansas City Power and Light Company, and Ted Workman, Ted Workman Advertising.

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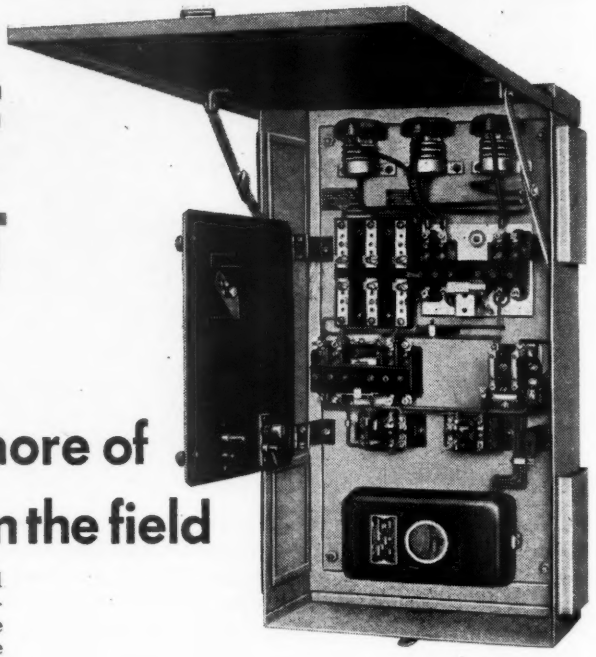
PROVED ON THE GULF

PROVED IN THE EAST



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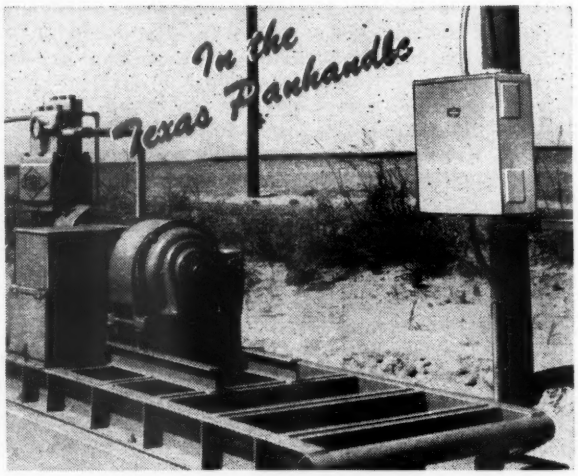


PERSONALS

Baird H. Markham

Baird H. Markham, retiring director of the American Petroleum Industries Committee of the American Petroleum Institute was honored at a dinner in New York City recently. Oscar John Dorwin, vice president and general counsel of The Texas Company and chairman of the American Petroleum Industries Committee, presiding, lauded Markham's achievements as director of the organization. Other tributes and messages honoring Markham came from various oil officials.

Markham retired on December 31 under the Institute's retirement program. He has served as chief executive of the committee since 1933, when it was organized to study tax and government regulatory problems affecting the petroleum industry and its customers.

Born in Decatur, Texas, he attended college at Texas Christian University. He joined the public and industrial relations department of the Marland Oil Company in 1927. Shortly thereafter he was made assistant general manager of that company and was later elected its treasurer. Following the merger of the Marland Oil Company and the Continental Oil Company, under the latter name, he became comptroller and assistant to the president of the new firm.

As a result of his organizational achievements with the Continental Oil Company, the Mid-Continent Oil and Gas Association, and the National Guard, Markham was chosen on January 1, 1933, as director of the newly-established American Petroleum Industries Committee.

John J. V. Forbes has been named director, United States Bureau of Mines, Department of the Interior. He succeeds Dr. James Boyd, who resigned recently to enter business. Forbes, who began working as a breaker boy in the mining country at the age of 10, was graduated from the Kutztown, Pennsylvania, State Normal School, now a teachers' college, and later from Penn State. He joined the Bureau of Mines in 1915. He was appointed chief engineer in the safety division in 1927 and chief mine inspector of the Bureau in 1941. Since 1948 he has been chief of the health and safety division.

John R. Evans and **Leslie A. Thompson** have been named to the board of directors of Stanolind Oil and Gas Company, it was recently announced by E. F. Bullard, president.

At the same time, Bullard announced **George W. Clarke,** former director of exploration and a board member, is new manager of the central division in Oklahoma City, replacing J. H. Forrester who was recently appointed manager of research for Standard Oil Company (Indiana). **F. J. Schempf,** who was manager of the Texas-Louisiana Gulf Coast division at Houston, succeeds Clarke in Tulsa as director of exploration.

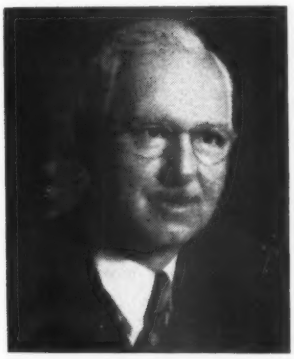
The new division manager at Houston will be **F. R. Yost,** former manager of the producing department and a board member. **Frank Lindeman, Jr.,** general superintendent of the producing department, has been named manager of the producing department. The post vacated by Lindeman will be filled by **Whitney M. Elias,** who was chief engineer of the producing department. **Lewis W. Finch,** chief production engineer under Elias, has been advanced to chief engineer.

Oscar John Dorwin, general counsel, has been made vice president and general counsel of The Texas Company. **A. N. Lilley,** general manager, foreign operations — Eastern Hemisphere, becomes vice president in charge of that department. **James H. Pipkin** has been promoted from general manager of industrial and public relations to vice president in charge of that department. **A. M. Ottignon,** assistant to the president was elected a vice president and will head Texaco's newly created supply and distribution department.

James F. Hewson retired recently after more than 34 years' service with Standard Oil Company (Indiana). He is succeeded by **Donald A. Monro,** chief engineer of the manufacturing department, who will serve under Harry F. Glair, the new director of purchases. Hewson was graduated in engineering from the University of Michigan in 1909. He began working for Standard Oil in 1917 in the estimating branch of the engineering department at the company's Whiting, Indiana, refinery.

Maurice B. T. Davies, formerly manager of the auditing department, Deep Rock Oil Corporation, has been appointed manager of the accounting department. He is succeeded by **W. Paul Hodges,** who was formerly assistant manager. **John W. Featherston, Jr.,** who was formerly manager of the accounting department, becomes assistant to the controller.

Davies joined Deep Rock in 1949 and Featherston also joined the company in July of 1949.



E. Constantin, Jr.

E. Constantin, Jr., prominent oil man and Texas cattle raiser, was elected a director of the Mercantile National Bank at Dallas at its directors meeting recently.

Constantin is president of Texas-Canadian Oil Corporation, which owns oil and gas leases and produces oil in Texas, Louisiana, and Arkansas.

He is also a major partner in The Southland Company and Coroco Drilling Company. Constantin is also engaged in water flooding operations in Illinois, and Kentucky.

J. H. Pipkin

A. N. Lilley

A. M. Ottignon

O. J. Dorwin

Walter C. Pew has been elected to the board of directors of Sun Oil Company. Pew, who has had previous service as a director, was general sales manager of Sun Oil Company for four years before entering the armed forces during World War II. He joined Sun in 1922.

Pew was commissioned a major in the U. S. Army in 1942. Later, with the rank of colonel, he served as deputy chief of the Petrol, Oil and Lubricants Section of General Eisenhower's staff.

Don Campbell, John Canning, and **J. M. Patterson** have been named assistant directors of public relations for Standard Oil Company (Indiana). The three will specialize respectively in administration, communication through outside media, and projects and communication in company channels. Campbell has been copy chief for Standard since 1949. He is a graduate of Kalamazoo college, Michigan.

Canning became associated with Standard in 1935; became press representative in 1945. He is a graduate of Grinnell college and received a master's degree from Northwestern University.

Patterson joined the company in 1946. He is a graduate of Birmingham-Southern college, and holds a master's degree from Emory University.

Arthur J. Kerr, of Pittsburgh, has been named director of the General Components Division, National Production Authority, U. S. Department of Commerce. Kerr replaces **Eugene F. McCarthy,** who was on leave from his position as vice president of Beals, McCarthy and Rogers, Inc., of Buffalo, N. Y. McCarthy had been serving with NPA under the agency's rotation policy, which generally has permitted key men from industry to leave their companies for six months tours of duty with the Government to assist in the mobilization program. He is now on leave from the position of vice president of the Rockwell Manufacturing Company.

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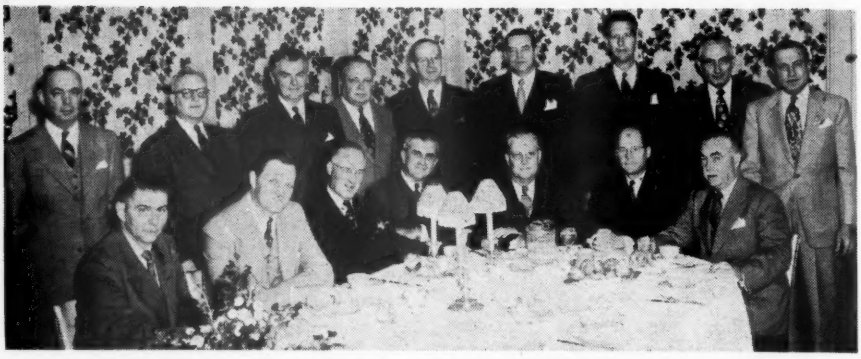

Officials of Dresser Operating Companies Industries, Inc.

Dresser Operating Heads Meet in Chicago, Illinois

During a conclave of officials of Dresser Operating Companies Industries, Inc., Dallas, Texas, the parent organization, to discuss an executive training program during a recent meeting at the Blackstone Hotel in Chicago, a recess was called long enough to have the group photographed. In accompanying photo, left to right standing are: Willard Johnson, president, Magnet Cove Barium Corporation, Houston, Texas; Robert H. Owens, president, Roots-Connersville Blower Corporation, Connersville, Indiana; J. H. Rosecky, general manager, Torrance Plant, Ideco Division of Dresser Equipment Company, Torrance, California; C. Paul Clark, president, Clark Brothers Company, Olean, New York; Eric Flaschar, president, Stacey Brothers Gas Construction Company, Cincinnati, Ohio; Otto Hammer, president, Security Engineering Company, Inc., Whittier, California; W. O. Cook, general manager, Beaumont plant, Ideco Division of Dresser Equipment Company, Beaumont, Texas; L. T. Wold, vice president, Kobe Division of Dresser Equipment, Huntington Park, California; C. E. Ponkey, vice president, Ideco Division of Dresser Equipment Company, and general manager Columbus plant, Columbus, Ohio.

Seated: T. L. Moody, director of industrial relations, and R. P. Brown, director of personnel and organization planning, Dresser Industries, Dallas; A. R. Weis, president, Pacific Pumps, Inc., Huntington Park; H. P. Boncher, general manager, Dresser Manufacturing Division, Bradford, Pennsylvania; R. E. Reimer, vice president, secretary and treasurer, H. N. Mallon, president, and J. B. O'Connor, executive vice president, Dresser Industries, Inc., Dallas.

New Yorkers Fly to California. Aboard a Johns-Manville plane, these men recently flew to Bakersfield, California, where they were entertained by the Nineteeners. At top of the steps is Bill Vanderkloot, former personal pilot to Winston Churchill. Next are Jack O'Brien and Leslie A. Baldwin, vice presidents, Johns-Manville. Second row: Elmer Ogden, manager, Columbian Rope; E. W. "Bill" Beck, assistant manager of purchases, Socony Vacuum. Front row: Joe Taylor, general purchasing agent, Socony Vacuum; Henry McAdam, vice president, Jones & Laughlin Supply; Frank Schlemmer, purchasing agent, and Phil Hauek, general purchasing agent, The Texas Company.

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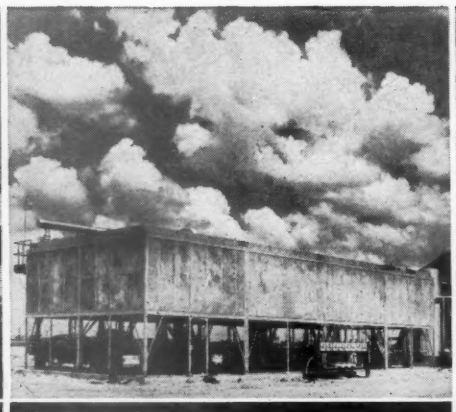

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ON A ROOF

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PIONEERS IN HEAT TRANSFER APPARATUS

▸ **Reginald J. S. Pigott,** director of the engineering division of Gulf Research and Development Company, a subsidiary of Gulf Oil Corporation, has been elected president of The American Society of Mechanical Engineers for 1952, it was announced at the society's 72nd annual meeting recently.

The regional vice presidents elected are: **Willis F. Thompson,** chief mechanical engineer, Westcott and Mapes, Inc.; **Ernest H. Hanhart,** consulting mechanical engineer; **Ernest S. Theiss,** assistant chief engineer, Davey Compressor Company, and **Samuel H. Graf,** (reelection), director, engineering experimental station, Oregon State College.

Elected directors-at-large were **Albert C. Pasini,** superintendent, production department, The Detroit Edison Company, and **Paul B. Eaton,** head, mechanical engineering department, Lafayette College, Easton, Pennsylvania.

▸ **T. A. Abbott** has been appointed to a new position as manager of the engineering research department of Standard Oil Company (Indiana). Dr. R. B. Jacobs will be appointed to a new position as technical director of the department. Abbott joined Standard in 1946 as executive director of the engineering research department. He previously had served with Republic Flow Meters Company, Armour Research Corporation, Kellex Corporation, and General Electric Company, and had taught electrical

Reginald J. S. Pigott

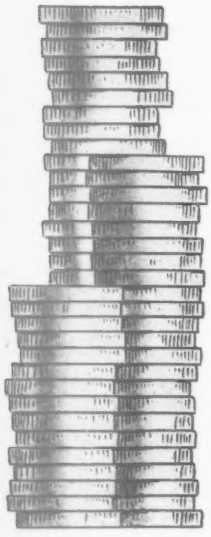
engineering at Yale University. A native of Kansas City, Missouri, he was graduated from Washington University. Dr. Jacobs joined the company in 1947. He received his Ph.D. from California Institute of Technology and did post doctorate work at Harvard University and Massachusetts Institute of Technology.

▸ **Don Attaway** was named general chairman of the petroleum section of the National Safety Council at the annual Safety Congress held in Chicago, Illinois, recently. Attaway is safety engineer for the Arkansas Fuel Oil Company. He has been a member of the executive committee and chairman of the sub-committees and vice general chairman in 1950.

▸ **E. E. "Ernie" Pyles,** vice president of Jergins Oil Company, has just been elected a director. Pyles is recognized throughout the oil areas of the United States as a forceful and effective crusader for petroleum industry causes and has long campaigned vigorously for states ownership of tidelands and retention of the oil depletion allowance. He is a former president of Southwest Exploration Company; is currently a member of the Military Petroleum Advisory Board and the National Petroleum Council, and is also president of the San Joaquin Valley Producers' Association.

▸ **H. N. Pardee,** independent oil producer and former production executive with the Texas Company and the Humble Oil and Refining Company, has been retained by the International Correspondence Schools of Scranton, as a consultant on petroleum courses. The appointment was announced by John G. Remsen, director of the school of chemical engineering at I. C. S.

Pardee served Humble Oil and Refining as superintendent of production, North Central and West Texas division, and later was division manager with The Texas Company in charge of production operations, Oklahoma, Kansas and Illinois division. He was also at one time in charge of field operations of the Landreth Petroleum Company of Fort Worth, Texas.



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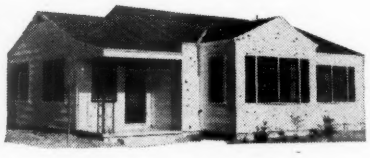

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▸ **F. W. Scheineman,** assistant chief engineer of the manufacturing department of Standard Oil Company (Indiana), has been promoted to chief engineer. He will succeed D. A. Monro, whose appointment as manager of the company's purchasing department has been previously announced.

Dr. F. H. Blunck, superintendent of the projects division at Standard's Whiting, Indiana, refinery, has been advanced to a new position in the general office manufacturing department as manager of the projects, capital expenditures, and miscellaneous contracts division.

The manufacturing department has made three other personnel changes. **C. A. Cogan,** section supervisor, has been appointed to a new position as superintendent of the projects, capital expenditures, and miscellaneous contracts sections. **F. C. Smith,** section supervisor, became superintendent of the operations and cost control sections, a new position. **W. N. Bercaw,** personnel section supervisor, was named superintendent of the personnel section.

Scheineman, a graduate of the University of Illinois, joined Standard in 1926 as an engineer at its Whiting refinery. Dr. Blunck joined the company in 1936 as a chemist in the research department at Whiting. During World War II, Dr. Blunck was in the chemical warfare service and saw overseas duty.

Cogan became associated with Standard in 1934 as a chemist at Whiting. He was graduated from Massachusetts Institute of Technology. Smith, a graduate of Cornell University, joined the company in 1943 as a chemical engineer at Whiting. Bercaw joined the company in 1917 as an employment bureau assistant at Whiting. He was graduated from Indiana University.

▸ **Charles Stokely,** a Montgomery, Alabama, attorney has been named to the State Oil and Gas Board of Alabama. He succeeds Dr. Milton Fies. The board now consists of **Lindsey C. Boney,** chairman, **Matt L. Blount,** and **Charles Stokely,** members.

DEATHS

▸ **Floyd Morgan,** 35, died of a heart attack while enroute from Evanston, Illinois, to St. Louis, Missouri, on a business trip, December 8. Tulsa sales manager for Larkin Packer Company, Morgan was formerly advertising salesman for *Independent Monthly* and *The Petroleum Engineer.* His survivors include his wife and three children.

▸ **David S. Kilgour,** who retired last July 1 as secretary of the Western Oil and Gas Association after 26 years service, died suddenly of a heart attack. He was 60 years of age. Kilgour joined the Association, then known as the Chamber of Mines and Oil, in 1925 and served successively as auditor and assistant secretary before being named secretary in 1944.

An accountant by profession, he was a past president of the Petroleum Accounts Society of Los Angeles.

From 1933 to 1944, Kilgour was secretary of the Pacific Coast Section of the Division of Production of API and was on its advisory committee.

▸ **W. C. MacMillan,** senior vice president, Continental Oil Company, died recently in Glendale, California. An employee of Continental for more than 23 years, MacMillan began as an instrument man in the geological department, becoming vice president in charge of production, assistant to the president, a company director, and then senior vice president. He attended Brown University, Providence, Rhode Island.

▸ **Frank A. Billstone,** 70, former treasurer and director of The Ohio Oil Company, died recently in Blanchard Valley Hospital where he had been confined for the past two weeks with a complication of illnesses. On his retirement in 1946, Billstone had served the company for more than 42 years, rising from a clerical position to guide its accounting and financial affairs.

Billstone was first employed in the Oil City, Pennsylvania, office in 1904. Following service in Kansas City, Missouri, and Marshall, Illinois, he was transferred in 1907 to the accounting department in the general office at Findlay. He was elected treasurer in 1927, and a director in 1934.

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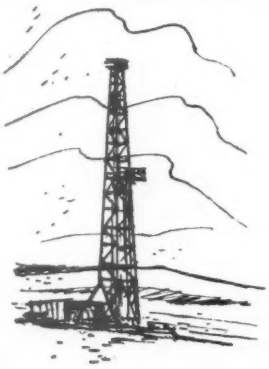

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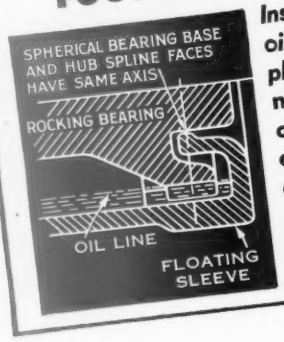

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INDUSTRY'S STANDARD FOR 31 YEARS

How to Estimate Crude Oil Reserves By Decline Trend Method

Charts and formulas to make needed calculations much easier

R. W. CLARK, JR.*

ONE of the continuing assignments of the petroleum engineer is the estimation of crude oil reserves. Depending upon the purpose, the estimates are made on several different bases: By fields, pools, properties, individual wells, and selected groups of wells. The job is never complete. Changes in prices and costs affect economic limits; changes in operating methods and mechanical condition of wells affect production rates; new discoveries, new zones, redrills, and abandonments all contribute to changes in the picture. By customary practice, a substantial portion of the work involves tedious summation of hypothetical approximations.

This subject of reserve estimates has been described at length in the literature[1] and can be reduced to two general methods:

1. Volumetric methods.
2. Methods based on extrapolation of some form of production history.

It is the purpose of this paper to:

1. Analyze quantitatively the decline trend of production rate which is the most commonly used form of the latter method.
2. To present a workable method of estimating future production by the use of charts or formulae which eliminate much of the drudgery of summation.

The usual technique employed to estimate future reserves is to plot the history of production rate of a well or group of wells in such a manner that a trend is indicated. A projection is made to some economic or other arbitrary limit, and the production is accumulated for the period of time concerned. Depending on established trends, it is customary to project the production rate on one of two general bases:

1. Constant percentage decline rate, or as hereafter called "constant decline"; in which case the production rate is plotted versus time on semi-log paper.
2. Variable percentage decline rate, or as hereafter called "variable decline"; in which case the production rate is plotted versus time on log-log paper. In this case, a certain amount of adjustment to the time scale by cut and try method may be necessary before a straight line projection is made.

In the following work, the areas under these curves have been integrated to give remaining reserves; and a few conveniences have been added for rapid calculation. It is divided into four parts:

1. Estimate by rule of constant decline.
2. Estimate by rule of variable decline and discussion.
3. Adaptations of variable decline for supplemental use with constant decline and type problems.
4. Appendix, including derivation of formulae.

As this paper is addressed primarily to engineers who are interested in results, in so far as it has been possible to do so, all symbols, derivations, and formulae have been placed in the appendix. It is important to note that the following work is in no sense a "method," for the function of the charts is to serve merely as a slide rule. The tools that are presented, however, should prove to be of assistance to the experienced appraiser in solving the types of problems for which they have been designed.

The following terms are introduced and defined:

1. Rate ratio: The ratio of production rate with respect to two instants of time—usually the production rate at an arbitrary limit to the current rate expressed as a per cent.
2. Current barrel: The average production rate expressed in barrels per day as of the beginning of the period to be estimated.

For variable decline application only:

3. Current time: The value of time on the time scale on log-log projection expressed in years that represents the current month.
4. Time ratio: The ratio of value of time at the economic or other limit to the value of current time on the time scale.
5. Decline ratio: The ratio of final decline rate to current decline rate expressed as a per cent.

EXCLUSIVE

PART 1.

Reserve Estimate by Rule of Constant Decline

Type problem:

Given:

Net oil price = $2 per bbl.
Working interest = 80 per cent.
Operating costs = $200 per month.

Average monthly production rate in barrels per day as plotted in Fig. 1 and tabulated in Appendix C.

To estimate:

A. Economic limit in barrels per day.
B. Remaining economic life in years.
C. Remaining economic reserves in barrels.

Solution:

A. Estimate economic limit.

Chart 1 — "Economic Limit" relates:

1. "Net" oil price in dollars per barrel: (Price of oil plus revenue and minus costs that can properly be reduced to a per barrel basis.)
2. Working interest in per cent.

*Richfield Oil Corporation.

[1] J. J. Arps, *Analysis of Decline Curves*, Trans. AIME, 1945.

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Now for the *first time* you can be sure of complete protection from these common enemies of your cooling water system through the use of the Betz Dianodic Method.

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In actual field operation, results are outstanding. Take, for example, the case of a large plant who operates with a 250 gpm circulation rate and a 15° F. temperature drop through the tower. Prior to the application of the Dianodic Method, the complete tube bundle was replaced due to corrosion after 18 months' operation. With the use of this advanced Betz technique over a period of 11 months, test specimens and inspection of the system showed freedom from corrosion or pitting

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For complete information on the Dianodic Method, write today for Betz Technical Paper No. 123.

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3. Operating costs in dollars per month. (Costs applicable on time basis.)

4. Economic limit in barrels per day,

as defined by equation 1.[2]

Thus: Apply first three assumptions from above in order given and economic limit = 4.1 bbl per day.

Note: The price and cost scales cover full ratio of 1 to 10. In this way, a price of 20 cents per barrel would yield 10 × the limit or 41 bbl per day. Likewise, a cost of $2,000 per month would yield 10 × the limit or 41 bbl per day.

B. Estimate remaining economic life:

In Fig. 1, a projection has been made to the economic limit of 4.1 bbl per day.

Chart 2 — "Economic life — constant decline" relates:

1. Production rate ratio,
2. Decline rate in per cent per year,
3. Remaining life in years,

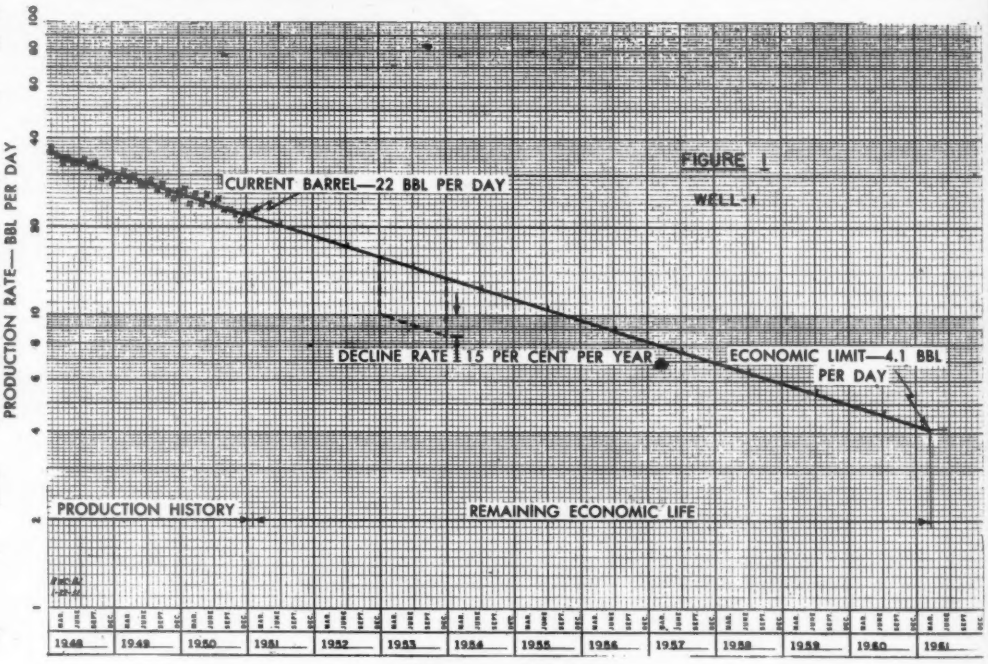

FIG. 1 — WELL 1

[2]Appendix.

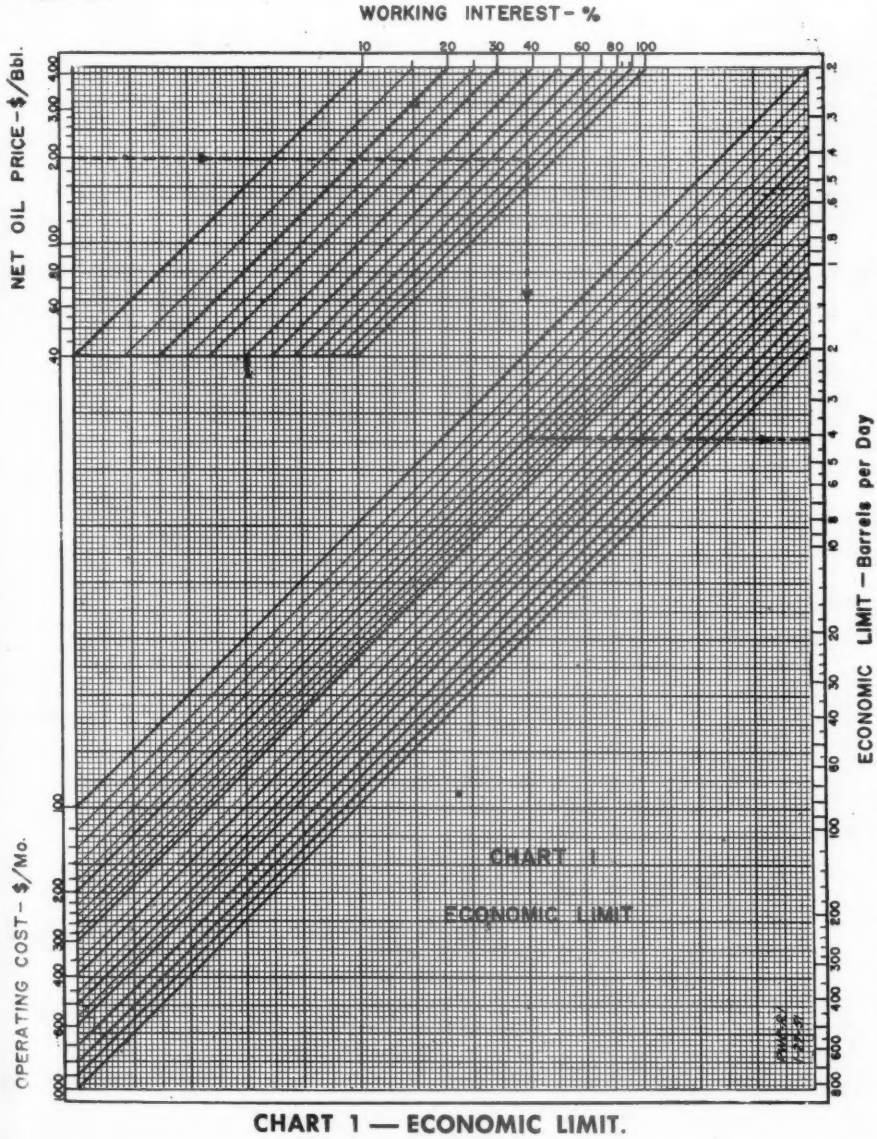

CHART 1 — ECONOMIC LIMIT.

as defined by equation 3.

Thus: in the problem

Current production rate	=	22 B/D
Economic limit	=	4.1 B/D
Calculated rate ratio	=	18.6 per cent
Projected decline rate	=	15 per cent per year
From Chart 2, remaining economic life	=	10.2 Years

C. Estimate remaining economic reserves:

Using the conventional method, the average projected production rate at each midyear is ticked off on Fig. 1, tabulated, and accumulated as follows:

Year	Projected average production rate
1951	20.2
1952	17.2
1953	14.6
1954	12.4
1955	11.4
1956	8.9
1957	7.5
1958	6.4
1959	5.4
1960	4.6
1961 (0.2) × (4.2)	0.8
Total	109.4

Est. reserves = 365 × 109.4 = 40,000 bbl

Chart 3 — "Economic reserves — constant decline" relates:

1. Decline rate in per cent per year,
2. Remaining life in years,
3. Remaining reserves in thousands of barrels per current barrel, as defined by Equation 5. Note that reserves per current barrel approach a limit as time increases.

Thus: following the problem to conclusion

Decline rate	=	15 per cent per year
Economic life	=	10.2 years
From Chart 3, reserves per current barrel	=	1.83 1000 bbl
And economic reserves	=	40,300 bbl

Chart 3-1—"Economic reserves — constant decline" relates:

1. Production rate ratio,
2. Decline rate in per cent per year,

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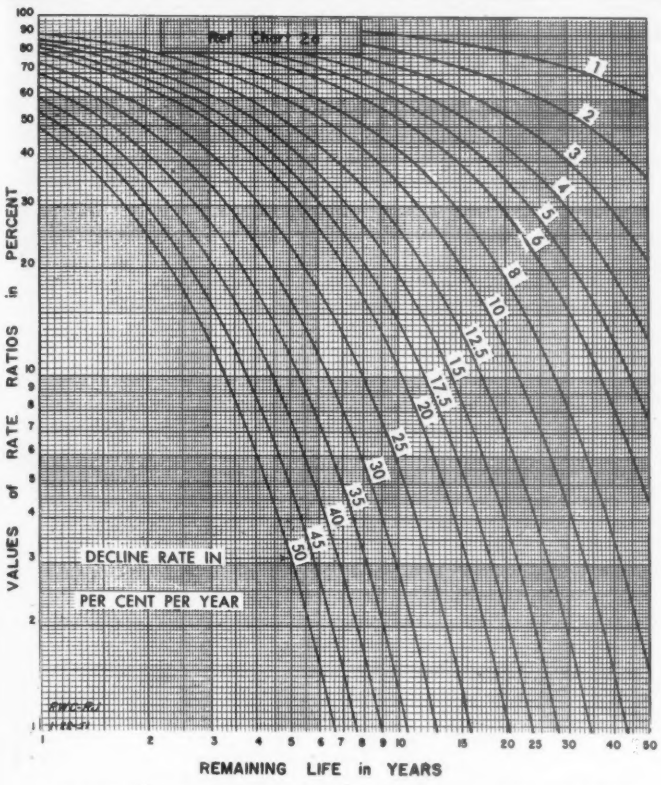


CHART 2—ECONOMIC LIFE—CONSTANT DECLINE.

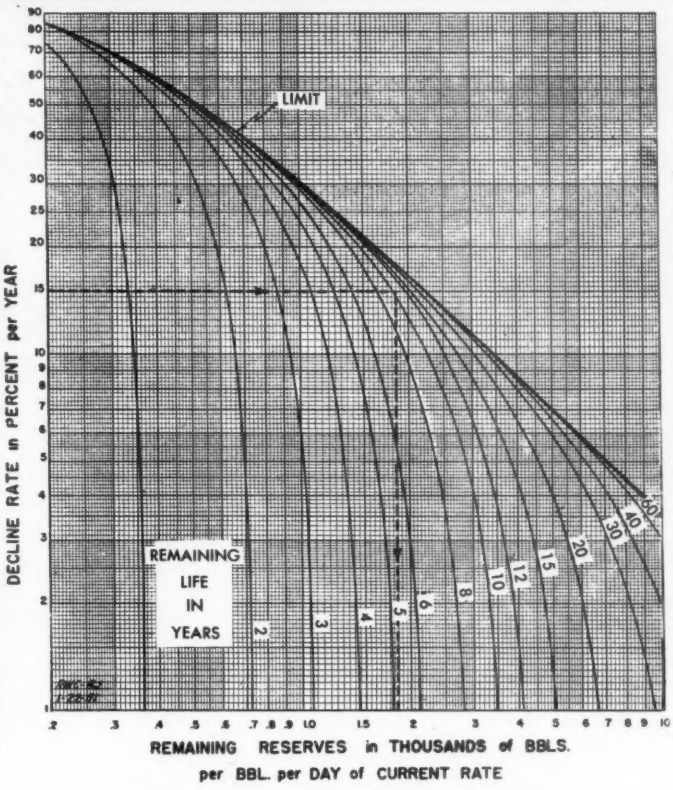


CHART 3 — ECONOMIC RESERVES.

3. Remaining reserves in thousands of barrels per current barrel, as defined by Equation 6. Note that reserves per current barrel approach a limit as rate ratio approaches 0.

Thus: in same example

Rate ratio	=	18.6 per cent
Decline rate	=	15 per cent
From Chart 3-1, reserves per current barrel	=	1.83 1000 bbl

PART 2.

Reserve Estimate by Rule of Variable Decline

Fig. 2 illustrates the production history of Well No. 2 plotted versus time on log-log paper using different values on the time scale for current time. Projections to an arbitrary economic limit of 6.5 bbl per day or 20 years are indicated. Again production is accumulated for each curve using the conventional method:

	A	B	C	D
1951	23.0	23.0	23.0	23.5
1952	19.5	20.0	20.1	20.8
1953	17.1	17.8	18.1	18.8
1954	15.2	15.9	16.5	17.2
1955	13.5	14.5	15.0	15.8
1956	12.0	13.3	14.1	14.8
1957	11.0	12.4	13.3	14.0
1958	10.0	11.5	12.6	13.2
1959	9.2	10.7	11.8	12.5
1960	8.5	10.0	11.3	11.9
1961	7.9	9.5	10.8	11.4
1962	7.4	9.0	10.3	11.0
1963	6.8	8.5	9.8	10.5
1964	[3].2	8.2	9.5	10.0
1965		7.8	9.1	9.7
1966		7.5	8.8	9.4
1967		7.2	8.6	9.1
1968		6.9	8.3	8.9
1969		6.6	8.0	8.6
1970		[3].2	7.8	8.4
Total	164.3	225.5	246.2	259.5
Est. reserves	60,000	81,500	90,000	95,000
Life in years	13½	19½	[4]20	[4]20

[3] (½ × 6.5 on account of ½ year.)
[4] Arbitrary.

Chart 4—"Economic reserves—variable decline" relates:

1. Rate ratio or time ratio,
2. Value of current time in years,
3. Slope of projection as ratio,
4. Remaining reserves in thousands of barrels per barrel per day of current production rate.

as defined by equation 10.

Thus, in the above example: Curve B using rate ratio

Current production rate	=	24.7 B/D
Economic limit	=	6.5 B/D
Calculated rate ratio	=	26.3 Per cent
Value of current time	=	61 months
or		5.08 years
Slope	=	— 85
From Chart 4, reserves per current barrel	=	3.26 1000 bbl
And economic reserves	=	80,500 bbl

In a similar manner: Curve C using time ratio

Current production rate	=	24.4 B/D
Value of current time	=	49 months
or		40.8 Years
Value of time at 20 year limit	=	289 months
Time ratio	=	5.90
Slope	=	—.65
From Chart 4, reserves per current barrel	=	3.66 1000 bbl
And economic reserves	=	89,500 bbl

The results of curves A, B, C, and D indicate that for:

1. A better than usual array of points,
2. A typical value of rate ratio,
3. A reasonable selection of values of current time on the time scale,

widely differing estimates of reserves

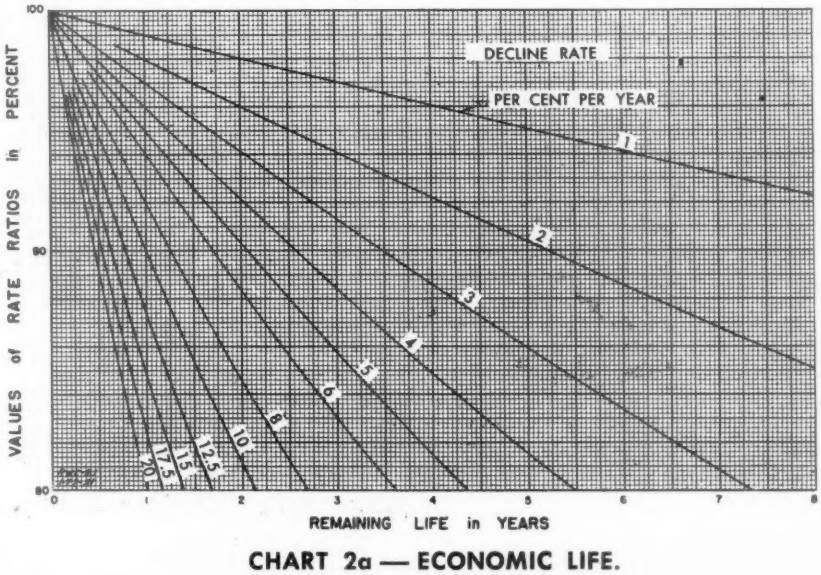
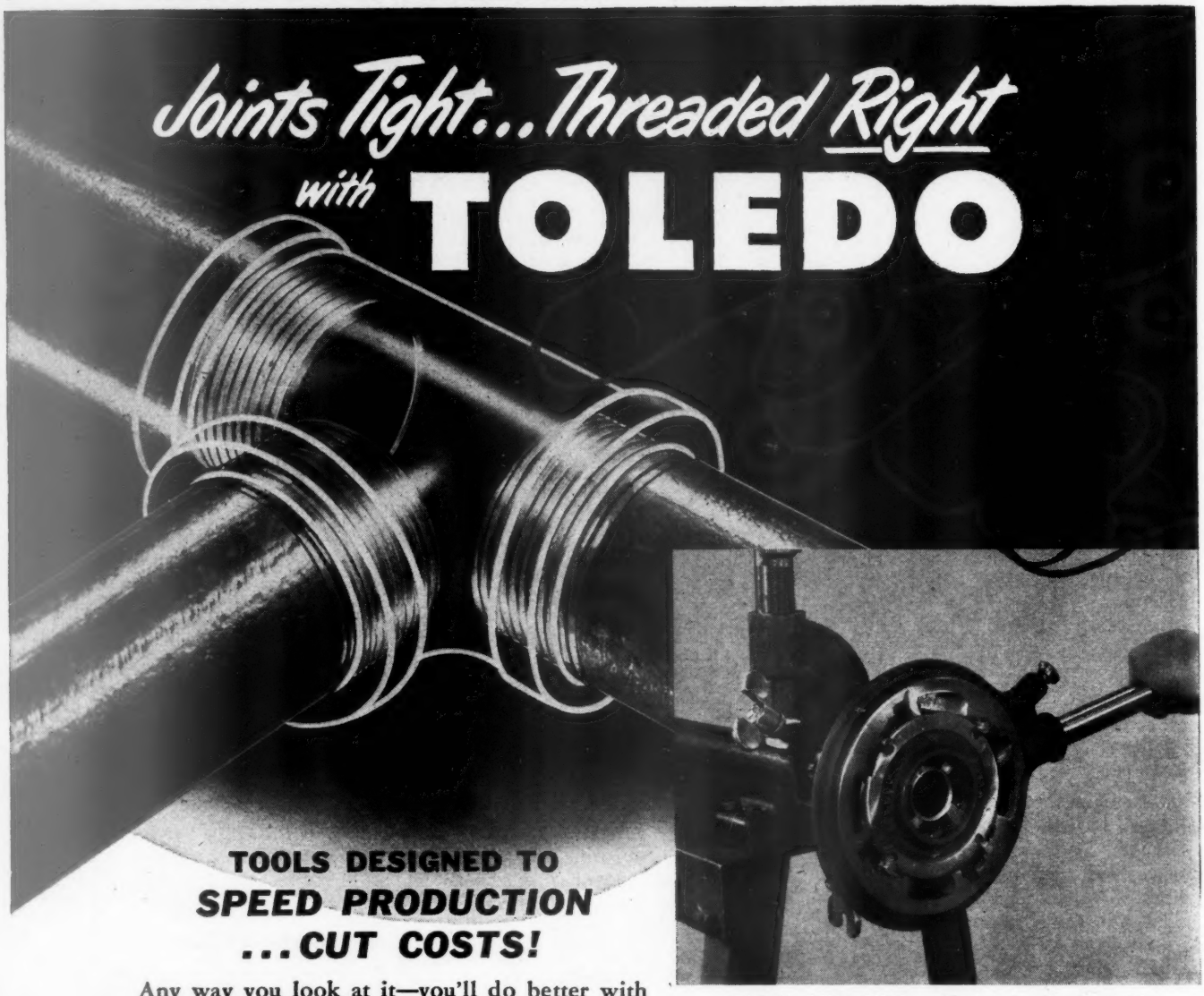


CHART 2a — ECONOMIC LIFE.

Joints Tight... Threaded Right with TOLEDO



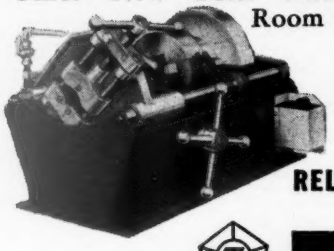
TOOLS DESIGNED TO *SPEED PRODUCTION ...CUT COSTS!*

Any way you look at it—you'll do better with TOLEDO Pipe Tools and Power Pipe Machines on the job!

Better workmanship...good mechanics for fifty years have found they can always depend on TOLEDO to produce clean-cut threads for tight, leak-proof joints.

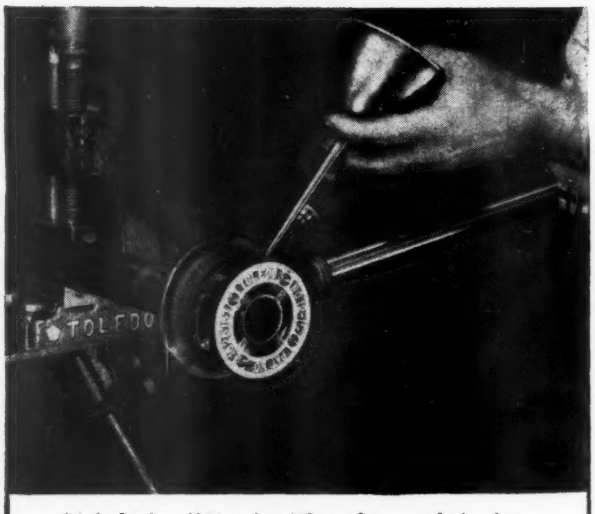
Faster production . . . whether it's hand tools or power pipe machines, Toledo gives you top-speed threading, cutting and reaming . . . ease of operation . . . accurate, efficient performance.

Lower costs . . . it all adds up to *big savings for you* in job-time and labor with Toledo dependability! Write for catalog on complete line. The Toledo Pipe Threading Machine Co., Toledo, Ohio. New York Office: 165 Broadway, Room 1310.



Toledo No. 999 2" pipe machine, wheel or knife cut-off.

Toledo SIMPACT—self-contained, adjustable threader, 1" to 2" pipe.



Toledo Small Ratchet Threaders made in three models, ⅛" to 2" pipe.

RELY ON THE LEADER

TOLEDO

PIPE TOOLS . . . POWER PIPE MACHINES . . . POWER DRIVES

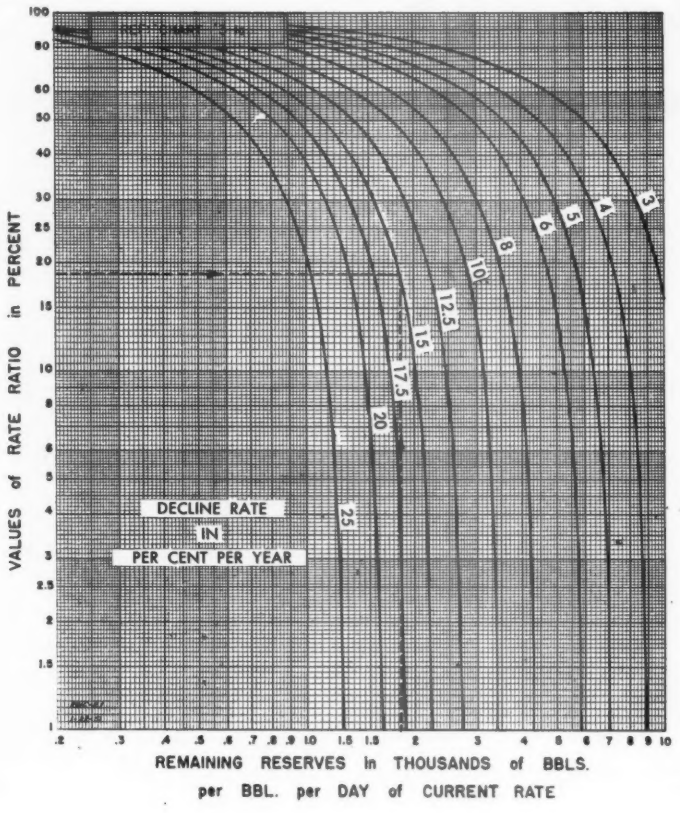

VALUES of RATE RATIO in PERCENT
DECLINE RATE IN PER CENT PER YEAR
REMAINING RESERVES in THOUSANDS of BBLS.
per BBL. per DAY of CURRENT RATE

CHART 3-1 — ECONOMIC RESERVES.

can be obtained. The thought is thus confirmed (as any juggler of estimates is well aware) that the method of decline trend is more of an art than a science, and hence requires an experienced operator. In order to assist the estimator to reach a conclusion, pertinent data of the several projections have been tabulated in Table 1.

Fig. 3 is a plot of the data on semi-log paper, which indicates the average decline rates for the three years of history, and a projection of 12 per cent based on the last 6 months production rate. For comparison, an estimate of reserves by constant decline is made from the following data:

Current production rate	=	25.3 B/D
Economic limit	=	6.5 B/D
Rate ratio	=	25.7 Per cent
Decline rate	=	12 Per cent (constant)
Economic life (Chart 2)	=	10.6 Years
Reserves per current barrel (Chart 3)	=	2.1 1000 bbl
Economic reserves	=	53,000 bbl

Evidently the key to a reasonable log-log projection lies in realistic decline rates from the present to the selected limit. From Table 1 it can be seen that of the curves A-D, only curve D has a good value for current decline rate. Probably curve A has the best value for decline rate at the limit, although experience based upon the individual field performance would modify that opinion. In order to give the estimator control over current and final decline rates with respect to the economic life, Chart 5 has been prepared which relates:

1. Current decline rate in per cent per year,
2. Final decline rate in per cent per year,
3. Decline ratio as per cent,
4. Remaining life in years,
5. Value of current time on time scale in years,
6. Time ratio,
7. Slope of projection as ratio,

as defined by equations 11 and 12.

Thus in the above example:

Current decline rate	= 12	per cent per year
Assume final decline rate	= 6	per cent per year
Then decline ratio (6÷12)	= 50	per cent
Assume arbitrary remaining life	= 15	years
From Chart 5:		
Value of current time	= 13.3	years
Value of time ratio	= 2.12	
Value of slope	= —1.8	

This "controlled" projection is plotted in Fig. 4.

Reserve estimate from Fig. 4 by conventional method:

Year	Production rate
1951	23.5
1952	21.0
1953	18.8
1954	16.8
1955	15.1
1956	13.8
1957	12.5
1958	11.4
1959	10.5
1960	9.6
1961	9.0
1962	8.3
1963	7.7
1964	7.2
1965	6.7
Total	191.9
Estimated reserves	70,000

Reserve estimate by Chart 4:		
Current production rate	=	25.3 B/D
Value current time	=	13.3 years
Time ratio	=	2.12
Slope	=	—1.8
Reserves per current barrel (Chart 4)	=	2.75 1000 bbl
Economic reserves	=	71,000 bbl

It is admitted that the production history does not follow the projection in Fig. 4, until the most recent months. This is what was intended, however, based on Fig. 3: a realistic current decline rate. The pertinent data are tabulated for comparison in Table 1.

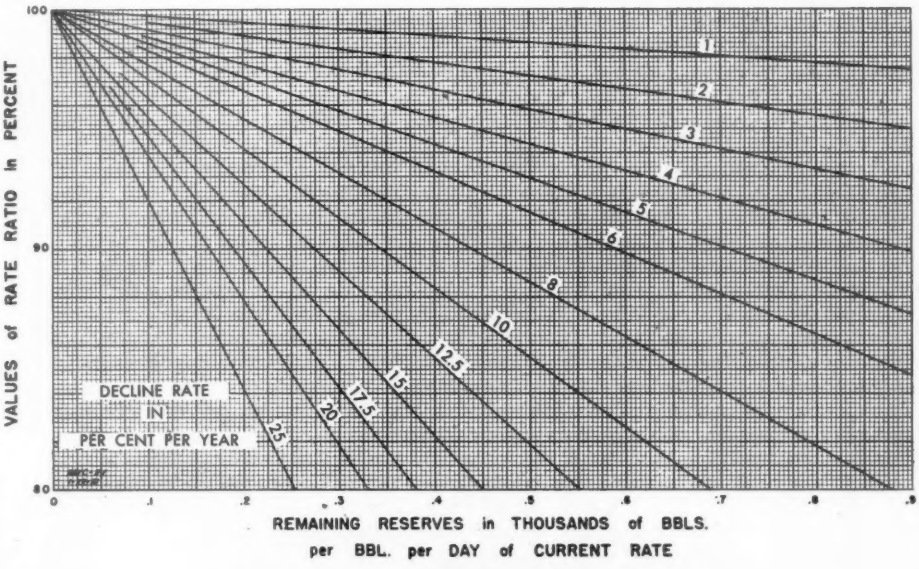

VALUES of RATE RATIO in PERCENT
DECLINE RATE IN PER CENT PER YEAR
REMAINING RESERVES in THOUSANDS of BBLS.
per BBL. per DAY of CURRENT RATE

CHART 3-1a — ECONOMIC RESERVES.

LAUGH with BARNEY

"Hello, Tower — Come in, Tower. I can't see through this fog and am running out of gas. Give instructions."

"Tower to pilot—Tower to pilot. Repeat after me: Our Father, who art in Heaven. . . .!"

* * *

A preacher walked in a tavern in the course of his welfare work, and ordered a glass of milk. By mistake he was served an egg-nog. After drinking it to the last drop he raised his eyes upward and was heard to say: "Lord what a cow."

* * *

Two gangsters were escorting a member of a rival gang across a lonely field on a dark rainy night.

"What rats youse guys are," groaned the doomed one, "making me walk through a rain like this."

"How about us?" growled the escort. "We gotta walk back."

* * *

Rich Oldster: We've known each other for so long, doctor, I won't insult you by trying to pay now for your help. I'm leaving you a handsome legacy in my will.

Doctor: That's very kind of you, I'm sure. By the way, just let me have that slip again. There's a slight change I want to make in your prescription.

A cowboy came into a hotel to get a room. He stepped up to the clerk and asked to register. The clerk asked, "Do you want a room with running water?"

"No," replied the cowboy. What do you think I am, a trout?"

* * *

Visitor: Why it's only 12 o'clock. It seemed much later.

Native: Around here that's all it ever gets. Then we start over.

* * *

"Where did you get that date? Buck teeth, crossed eyes, bow legs, bleached hair!"

"You needn't whisper, old man. She's deaf, too."

* * *

A guard from a lunatic asylum rushed up to a farmer and said, "I'm looking for an escaped lunatic. Have you seen him?"

The farmer puffed thoughtfully on his corn cob pipe and asked, "What does he look like?"

"He's very short," said the guard, "and he's very thin, and he weighs about 350 pounds."

The farmer, in amazement, wanted to know how a man could be short and thin and still weigh 350 pounds.

"Well," answered the guard impatiently, "I told you he was crazy."

HE THINKS LANE-WELLS RADIO-ACTIVITY WELL LOGGING IS OLD FASHIONED — HE WANTS TELEVISION-IN COLOR!
EXTRA MODERN OIL CO.
PRESIDENT
CR-SOI

Teacher: Johnny, what are the three great American parties?

Johnny: Democratic, Republican and cocktail.

* * *

The oldtimer watched the trombonist play for quite a long time . . . and said finally: "There's a trick to it — that feller ain't really swallering it."

* * *

Sign on a Hollywood street corner: "To avoid that run-down feeling, cross street carefully!"

* * *

A small boy trudged up to the librarian and slid a dirty and dog-eared edition of 'Advanced Calculus' onto the return desk.

The librarian automatically checked his card and turned to replace the book on its shelf when she noticed the title. Amazed, she spun to face the boy and said, "Rather technical isn't it?"

The youngster spread his feet, put his hands on his hips and stated defiantly. "It was that way when I got it!"

* * *

"Whatchagotna packidge?"

"Sabook."

"Wassanaimuvitt?"

"Sadiskshunery. Fullinaims. Wife's gonna gettaplecedog — anagottaget — tanaimferim."

* * *

Samuel Morse was an eminent painter before he invented the telegraph. He once painted a scene showing a man in death agony, and asked a physician friend to examine it. "Well?" Morse inquired after the doctor had very carefully scrutinized the picture. "What's your opinion?" The physician removed his spectacles, turned to Morse and commented: "Malaria!"

* * *

The doctor was visiting Rastus' wife to deliver her 12th offspring. On the way he saw a duck.

"Whose duck was that, Rastus?" he asked.

"That ain't no duck," replied Rastus. "That's the stork with his legs wore off."

* * *

If all of the folks who sleep in church were laid end to end, they'd be much more comfortable.

* * *

Our Girl Shirley says the first Adam-splitting produced Eve, a force which man in all the ages since has never gotten under control.

* * *

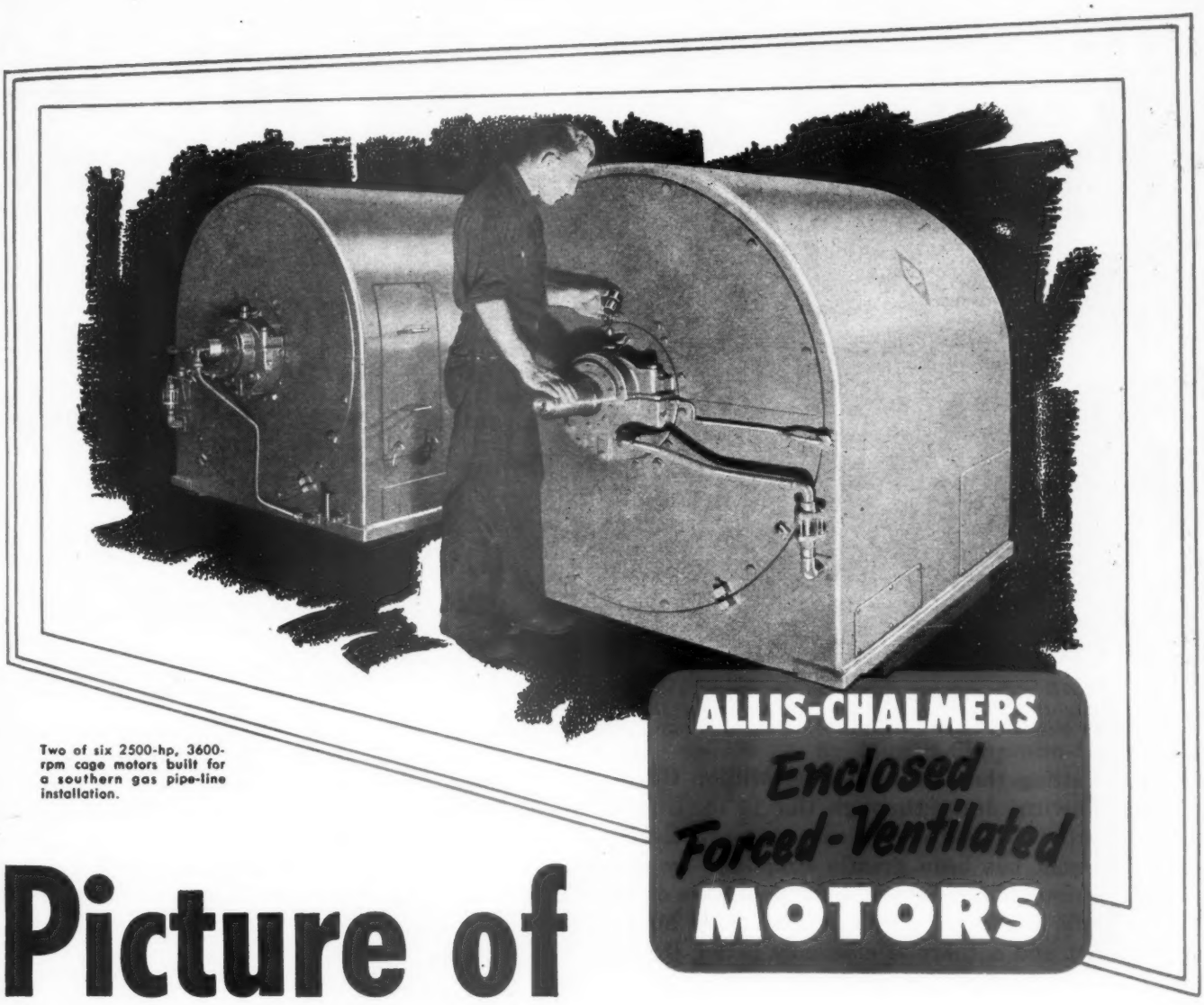
Pat came home with a much battered countenance; Biddy asked:

"Phwat happened?"

"Oh Cassidy and I had a set-to."

"An' would you let such a lousy wart like him beat you up?"

"Tut-tut Biddy; don't shpeak disreshpectful of the dead."



Two of six 2500-hp, 3600-rpm cage motors built for a southern gas pipe-line installation.

ALLIS-CHALMERS
Enclosed Forced-Ventilated
MOTORS

Picture of Economy

FOR PIPE-LINE STATIONS

Start with a few of these Allis-Chalmers enclosed forced-ventilated motors. To complete the picture, add a common ventilating system. *That's* what many engineers are prescribing for low-cost pipe-line stations requiring several large pump or blower motors.

There are good reasons for this. These motors cost very little more than open machines. But they lead a charmed life because they run . . . and run . . . and run . . . in an atmosphere of cool clean air. That makes them easy to live with because they need very little attention . . . and the heat they produce is discharged outside the motor room.

What's more, adequate protection for these hazardous locations is provided by supplying the ventilating air under positive pressure — during starting and during operation.

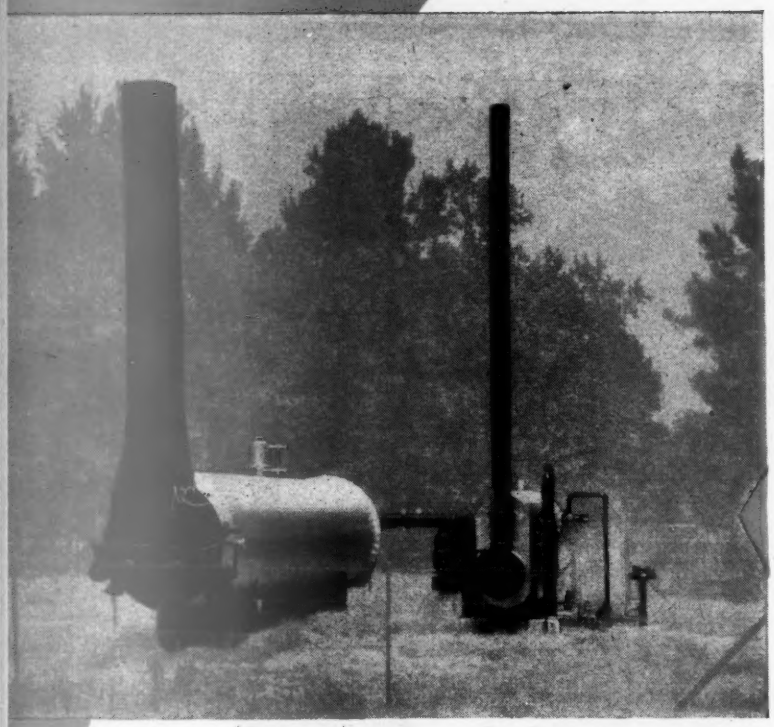
For best results, the motors must, of course, be designed to meet specific pipe-line requirements . . . *and Allis-Chalmers motors are!* For example, the motors shown above are made for connection to air ducts in the foundation, but other motors can be built for connections at the top or sides to fit your installation plans.

Details are important too. These motors have capsule-type bearings supported by split end shields. This permits easy access to the motor interior without exposing the bearings to dust and grit. Use of two oil rings per bearing assures uniform, uninterrupted lubrication. The supplementary forced-feed lubrication system used for these 3600-rpm motors is self-contained . . . and it's air-cooled . . . needs no cooling water supply.

Why not call in your nearby A-C representative. He can help you decide where to use these newly designed pipe-line motors. Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3535

ALLIS-CHALMERS



BS&B 70G indirect heater on Carthage, Tex. system. (Right) a 10 year-old BS&B indirect heater still in use for auxiliary service.

BS&B 70 G INDIRECT HEATERS

Make Sense • Save Dollars

. . . on This East Texas 12 Inch Gathering Line . . .

Putting the heat on the 40 Million CF of gas flowing daily through the 12 in. line of an extensive gathering system near Carthage, Texas, has been greatly simplified by the use of four BS&B Series 70 Giant heaters over a 12 mile stretch. With a 4 million BTU hourly input and a thermal efficiency better than 70%, these BS&B Giant indirect Heaters not only reduced the initial heater purchase and installation cost to a minimum but are saving money on fuel consumption and maintenance every day. They're constant proof that economy and efficiency are partners in BS&B oil field equipment.

7 ADVANTAGES OF BS&B "70" HEATERS

SAVES FUEL GAS—at rated capacity, the overall thermal efficiency is 70% or more—highest of any heater unit.

SAVES UNIT COST—"70" Series indirect heaters are fabricated in sizes ranging from 250,000 to 4,000,000 BTU input per hour—a heater for every gas and oil heating job.

SAVES MAINTENANCE COSTS—easier to service because firebox and flow coil can be pulled separately—from opposite ends.

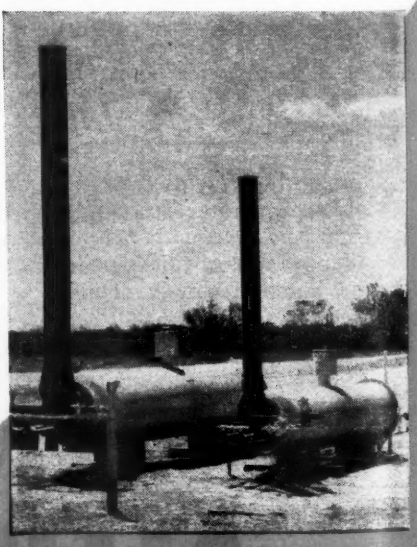
SAFER WATER LEVELS—the exclusive BS&B Water Saver condenses hot water vapor, returns it to main water bath.

GREATER FLOW TUBE SURFACE—it's the square feet of transfer surface that counts—the BS&B flow coil offers more surface.

GREATER SAFETY—the gas and oil are completely sealed from firebox—surrounded by water; the even heat of water bath reduces scaling, prevents burnouts.

BS&B ENGINEERING SERVICE—always available, the highly skilled, prompt service of your nearby BS&B sales engineer—the engineering facilities of Black, Sivalls and Bryson's Oil and Gas Division at Oklahoma City—and the 35 efficiently staffed and equipped sales and engineering branches maintained by BS&B in the oil country.

70S (standard) and 70B (bantam) BS&B heaters at a South Texas wellhead, utilized with two-stage separation. The BS&B 70 series heater reputation for reliability has made it the most popular for field installations.



EFFICIENCY BS&B RELIABILITY

BLACK, SIVALLS & BRYSON, INC.

OIL & GAS EQUIPMENT DIVISION, DEPT. 1c1

2131 WESTWOOD BLVD. • OKLAHOMA, CITY, OKLA.

OIL AND GAS TRADE NEWS

Bigelow-Liptak Moves Its Michigan General Offices

Bigelow-Liptak Corporation has celebrated its 25th birthday by announcing its move to larger and up-to-date general offices at 2550 W. Grand Boulevard, Detroit 8, Michigan. As a result, the move into the new air-conditioned offices provides additional floor space for the engineering of a wide variety of furnaces. Bigelow-Liptak designs are used to enclose boilers; for refinery heaters; coal, pulp and food dryers; metallurgical furnaces, and glass tanks.

Canadian Agents Named

T. D. Williamson, Inc., of Tulsa, Oklahoma, announces the appointment of Canadian Equipment Sales and Service Company of Edmonton, Alberta, and Toronto, Ontario, as its exclusive agent in Canada.

Offices Moved to Houston

The sales and accounting offices of Weatherford Oil Tool Company, Inc., are now in Houston, Texas, as the result of a recent move. They are housed in a building, purchased by the company, at 5920 Navigation Boulevard. Weatherford's general manager, R. H. Hume, has his headquarters in the Houston office. The administrative officers of the company, Jess E. Hall, Sr., Jess E. Hall, Jr., Elmer Hall, and John Hall, can be contacted at all times in Weatherford where the main factory will continue to be operated. Jess E. Hall, Jr., president of Weatherford Oil Tool, requests that all matters pertaining to sales and billing be taken up direct with the Houston office of the company. The telephone number is Woodcrest 7411.

Ralph Nation

Charles Stephen

Beaumont Cement Purchased By Mud Products, Inc.

The Beaumont Cement Sales Company, with offices now situated in the Pierre-Marquette Building in New Orleans, has been purchased by Mud Products, Inc., of Tulsa, Oklahoma. The new management of the Beaumont Cement Sales Company includes: Ralph Nation, vice president and general manager, formerly the Oklahoma division manager for Mud Products; and Charles Stephens, secretary-treasurer and office manager, formerly Tulsa office manager for Mud Products. Other sales and operating personnel of the purchased firm remain unchanged.

Pacific Valve Expands

Pacific Valves, Inc., manufacturers of steel valves, recently announced that it has acquired the complete plant of Pacific Forge, Inc., 1562 North Spring Street in Los Angeles. Pacific Forge will operate as a subsidiary to Pacific Valves employing approximately 50 employees at present with plans for future expansion. It was pointed out that this new subsidiary was acquired to assure delivery for Pacific Valve's vitally needed forged line of valves and forged parts for their cast steel line.

Garlock Export Divisions Consolidated in New York

The export operations of The Garlock Packing Company, manufacturer of mechanical packings, recently have been consolidated and the New York office has been made headquarters of this division, according to company officials. The division was moved to new offices at 30 Church Street.

The New York office will direct export operations for all parts of the world except distribution to the Phillipine Islands and the Hawaiian Islands, which will remain under the jurisdiction of Garlock's San Francisco office. R. S. Parker was appointed manager of the Garlock export division, with headquarters in New York. He has been the Far Eastern representative for The Garlock Packing Company for the past 25 years.

Dallas Office Established By Merritt-Chapman-Scott

Merritt-Chapman and Scott Corporation has announced the establishment of an office at Dallas, Texas, to serve as headquarters for the 91-year-old company's construction activities in the Southwest and Gulf Coast areas.

The new Merritt-Chapman and Scott office, at 704 Kirby Building, Dallas, will be headed by J. B. Allinson, whose appointment as M-C&S's regional representative in the Southwest was simultaneously announced by Ralph E. DeSimone, executive vice president and general manager of the company. Allinson is a resident of Dallas and before joining Merritt-Chapman and Scott had been active in a wide field of construction operations for the past 10 years, most of them in the Southwest.

R. H. Hume, Jr., left, is general manager of Weatherford Oil Tool Company, Inc., which recently moved into new offices in Houston, Texas. At right is the new building purchased by Weatherford Oil Tool where all matters pertaining to sales and billing will be taken care of. Hume's offices were formerly in Weatherford before the company's recent move to Houston.

Oil Center Tool Company of Houston, Texas, has opened a new warehouse store at 2316 Antelope in Corpus Christi. The new location is part of an expansion program to better serve the oil industry in South Texas. Mike Hunter is Southwest district manager with headquarters at Corpus Christi.

Hole Heads Offices of American Air Filter

The Canadian business of the American Air Filter Company, Inc., Louisville, Kentucky, is being handled by American Air Filter of Canada, Ltd., Montreal, P. Q. William G. Hole, formerly of Darling Brothers, Ltd., is in charge of all Canadian operations. Representatives will be established in the larger Canadian cities to handle the AAF line of air filters, electronic precipitators, and Roto-Clone dust collectors.

Tulsa Firm Established

A new firm, Mechanical Design, Incorporated, has been organized with offices at 517 Wright Building, Tulsa, Oklahoma. Operations were begun November 1. The new firm offers a complete mechanical engineering and design service to the petroleum industry and will specialize in refinery and gasoline plant design. Officers are: J. R. Lawrence, president; Herbert E. Dyer, vice president and manager; Maloy Stevenson, secretary, and Huff D. Peters, treasurer.

BJ Service Is New Name of International Cementers

E. S. Dulin, president of Byron Jackson Company, announces that at a recently held directors meeting of International Cementers, Inc., (now a wholly owned subsidiary), the name was changed to BJ Service, Inc., and as soon as the necessary permission is obtained from the various states in which BJ Service, Inc., is qualified, all operations will hereafter be conducted under the new name.

BJ Service, Inc., opened new service facilities at Seagraves, Texas, and Rankin, Texas, recently. A service station was recently opened at Williston, North Dakota, in order to render service to the new Williston Basin area.

Baldwin-Hill Acquires Rockdale Insulation Plant

To meet the growing need of industry and homes for mineral wool insulating products, the Baldwin-Hill Company, Trenton, New Jersey, has acquired the Rockdale insulation plant near Housatonic, Massachusetts. This purchase was made from the Eagle-Picher Company, Cincinnati, Ohio. The Rockdale plant will be operated to develop new Baldwin-Hill products as well as to manufacture and distribute Baldwin-Hill materials to the New England territory.

The facilities of this plant include the main production building, material handling bins and equipment as well as welfare and office buildings.

Vibradamp Stock Bought

Glass Fibers, Inc., of Toledo, Ohio, has purchased controlling interest in the Vibradamp Corporation with headquarters at Los Angeles and plant facilities at Los Angeles and Santa Clara, California. The newly acquired company utilizes a Glass Fibers' product, lightweight glass wool, in the manufacture and fabrication of specially-designed shock mounts, vibration mounts, and other products for defense weapons in addition to many commercial applications.

Varel Moves Into New Plant

Varel Manufacturing Company has moved into its new and enlarged plant at 9230 Denton Drive, Dallas, Texas. The company has announced that a round-the-clock schedule is being maintained in the rock bit department, and that larger inventories and on-the-spot deliveries are now available to users of the Varel rock bit. The enlarged floor space gives the plant 33,000 sq ft of additional space. New telephone number is ELmhurst 6487.

Seismograph Service Corporation employees at the annual meeting held in conjunction with the 20th anniversary celebration in Tulsa, Oklahoma, recently. They are, first row: J. G. Jackson, H. H. Andrews, T. H. Evans, L. G. Cornish, R. A. Pohly, H. C. Bickel, R. F. Aldredge, H. M. Thralls, A. J. Barthelmes, G. H. Westby, J. E. Hawkins, A. B. Chappell, J. L. Hull, Jr., J. E. Dorris, F. B. Leedy, R. W. Mossman, J. A. Ries, and R. S. Finn. Second row: Van Roberts, J. Henderson, W. H. Van Horn, E. D. Wilson, C. C. Smith, M. G. Steil, S. W. Wilcox, R. W. Saubert, C. E. McClure, R. E. Baum, H. R. Breck, E. H. Kurk, S. W. Fruehling, R. K. Finley, J. R. Blaisdell, C. C. Bury, R. W. Baltosser, Grace Gorham, and Grace Porch. Third row: E. D. Boatright, C. Vinyard, L. R. Earl, C. H. Massie, H. W. Haag, B. G. Preston, C. E. McMunn, M. B. Jones, R. S. Fishcer, R. S. Sprecker, H. L. Richardson, F. D. McCalman, W. R. Holford, P. E. Goodwin, R. E. Lee, F. R. Hess, Pearl Welch, H. R. Parmenter, J. B. Rogers, C. W. Hyatt, E. A. Langpaul, R. O. Durst, R. L. Heineck, and J. L. Catt. Fourth and fifth rows: H. S. Eshelman, L. G. Morris, H. S. Jennings, D. B. Harris, M. A. Hancock, A. M. House, J. E. Ward, R. L. Whitaker, F. M. Cowell, J. C. Davis, A. A. Milton, F. I. Garrette, W. H. Denton, F. E. Haag, H. Jenkins, J. W. Hortman, R. S. Phillipi, W. R. Doll, L. S. Buckie, L. L. Hauth, W. H. Gage, A. H. Manhart, W. W. Green, W. O. Heap, and J. C. Hammer.

more and more pipelines use

purchased *Electric Power* to provide the push...

In the famed Permian Basin of West Texas, *PEP is on the job 24 hours a day . . . rain or shine, giving efficient, economical service. Electric Power makes for a neat, dependable operation such as the pumping station in Andrews County, pictured above. Electric power assures economy, reduces operating maintenance and labor costs and it's dependable. Why not investigate the many advantages of Electric Power? Call the Power Engineer of your nearest Electric Power Company. Get facts and figures on how Electric Power will reduce your operating costs.

*PEP — Purchased Electric Power

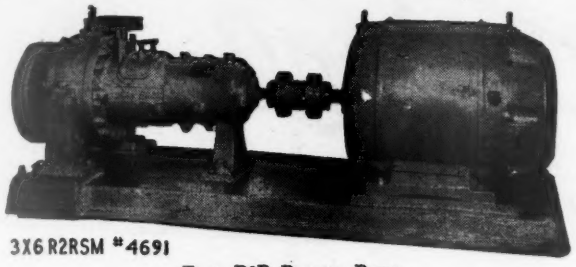
Petroleum Electric Power Association

ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

CALL YOUR NEAREST ELECTRIC SERVICE COMPANY FOR MORE FACTS
OR ADDRESS YOUR REQUEST TO P. O. BOX 2771, DALLAS, TEXAS

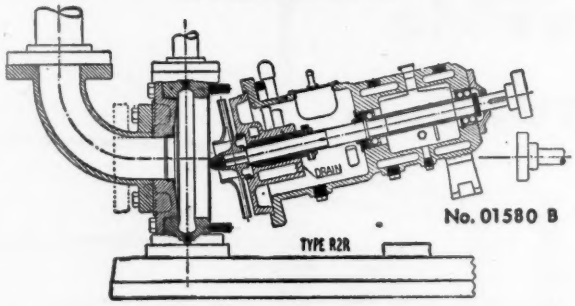
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



3X6 R2RSM #4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R processs pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

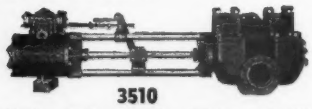
OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

4040H

Close Coupled Centrifugal Pump



3510

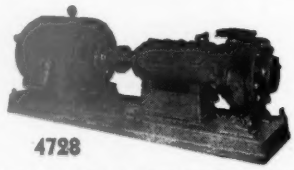
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

4043 AA

Pedestal Mounted Centrifugal Pump

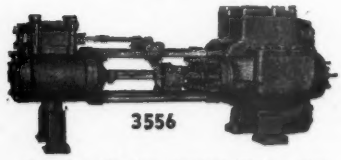
3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump



3556

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

Company Formed to Promote Wire Line Spooling Methods

F. L. LeBus, Sr., has announced the formation of LeBus International Engineers, Ltd. Executive offices for the new company have been opened at 300 Wichita National Bank Building, Wichita Falls, Texas. LeBus International Engineers, Ltd., was organized exclusively for the purpose of promotion and and development of wire line spooling methods. Sales and service for the new firm will be on an international scope. The LeBus Rotary Tool Works, Inc., Longview, Texas, will continue to manufacture all materials. Earl J. Calk will act as sales manager and F. L. LeBus, Jr., will operate out of the Longview office on sales and material distribution.

Penn Changes Name

The firm name of the Penn Electric Switch Company has been officially changed to Penn Controls, Inc., according to an announcement issued by Albert Penn, president. Explaining the name change, Penn stated: "For some years we have considered changing the name of our company to describe more accurately the character of our business. Years ago the name 'Penn Electric Switch Co.' was descriptive of the products we manufactured. Over the years, however, our product line has grown to include many items other than electric switches. During this time our products have become generally known to our customers as 'Penn Controls'." The announcement emphasizes that the name change will not alter management, general policies, or operation of the company; nor will it have any effect on contracts, agreements, or purchase orders.

Blaw-Knox Grants License To Houdry Process Firm

Chemical plants division of Blaw-Knox Company has been licensed by the Houdry Process Corporation to use certain of the latter company's processes, designs for equipment, and technical information relating to catalytic treatment of petroleum and other hydrocarbons. This further enables Blaw-Knox to offer services in the engineering and construction of plants and processing facilities to the refining and petrochemical industries.

Pump Plant Contract Let

Fairbanks, Morse and Company has awarded a contract to the S. Patti Construction Company of Kansas City, Missouri, for the yard work for its new pump plant in Kansas City, Kansas. The contract is on a cost plus basis and will be for the sewers, roads, and other ground detail.

Contracts, as yet, have not been let for the actual construction of the plant which is scheduled to begin next spring. The new plant will have a machine shop containing 190,000 sq ft of floor space, a foundry with 150,000 sq ft, and an office building with 20,000 sq ft.

W. B. Taylor

M. O. Johnston

M. O. Johnston Companies Sold to Johnston Testers

M. O. Johnston, who parlayed a combination of Spindletop roughneck experience and a good idea to one of the industrial giants of oil field specialty services, has sold his group of operating oil field service companies to Johnston Testers, Inc., of Houston, Texas. He is not bowing out of the industry, but is a substantial stockholder and a director in the corporation that purchased his operating organizations.

W. B. "Bill" Taylor, who began his oil field career in Eldorado, Kansas, and migrated to California in the early 1920's and later became associated with M. O. Johnston in the middle 1930's, heads Johnston Testers, Inc., as president. Since 1942 he has been vice president and general manager of Johnston Oil Field Service Corporation, an M. O. Johnston organization that has its headquarters in Houston and operated throughout the Gulf Coast and Mid-Continent areas.

The M. O. Johnston group consisted of M. O. Johnston Oil Field Service Corporation, of Los Angeles, operating in California and Rocky Mountain States; Johnston Oil Field Service Corporation of Texas, operating in the Mid-Continent; M. O. Johnston Oil Field Service, Ltd., of Edmonton, Canada, operating in the Dominion of Canada; and M. O. Johnston Oil Field Export Corporation, of Los Angeles, engaged in exporting Johnston drill stem testing equipment.

Officers of Johnston Testers, Inc., are: W. B. Taylor, president; J. E. Smith, O. W. Ward , and T. M. Johnston, vice presidents; H. F. Junker, secretary-treasurer; and J. H. Hambrick, Jr., assistant secretary-treasurer.

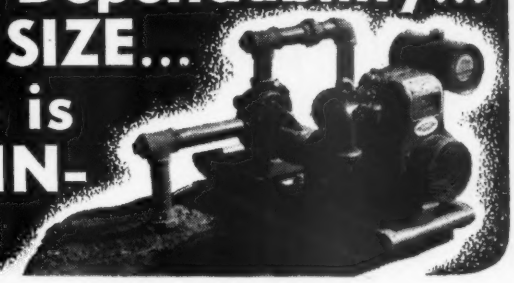
Directors of the new corporation are W. B. Taylor, M. O. Johnston, E. C. Johnston, H. F. Junker, J. E. Smith, L. B. Martin, Ed Rotan, and Richard J. Kneedler.

Gustafson Gets New Post

W. L. Gustafson has been named power industry sales manager west of the Mississippi River for Minneapolis-Honeywell Regulator Company. His new assignment became effective January 1, it was made known by William H. Steinkamp, field sales manager for the company's Brown Instruments division.

Gustafson, who will make his headquarters at the company's San Francisco branch, has been with Honeywell since 1926. He represented the company in the St. Louis, Chicago and Minneapolis-St. Paul offices, and was transferred to San Francisco in 1937.

L-O-N-G on Dependability... SHORT on SIZE... This Pump is WISCONSIN-POWERED

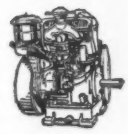


Another typical oil field job for a Wisconsin Heavy-Duty Air-Cooled Engine. This single-cylinder model is powering an oil-circulating pump at an Oklahoma field.

Oil field men and engine power users in many other fields endorse the power and down-right dependability of Wisconsin Engines. Part of this acceptance is due to such features as thrust-absorbing, self-cleaning tapered roller bearings at both ends of the crankshaft; an easily-serviced OUTSIDE magneto with impulse coupling for quick, any-weather starting and running. Equally important features are a positive, almost-attention-free lubrication system and built-to-deliver design, top to bottom.

Your power investment costs LESS over the LONGEST PERIOD when you use Wisconsin Engines.

4-cycle single-cylinder, 2-cylinder & V-type, 4-cylinder models, 3 to 30 hp.



WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

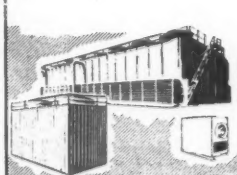
WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

Adequately Sized for Peak Efficiency!

Pritchard Quality Cooling Towers

You can depend on Pritchard Quality Cooling Towers to get the job done more efficiently...more economically. Pritchard Towers are guaranteed to meet your peak loads as well as normal needs because they're *adequately* sized and *thoroughly* engineered. Quality materials assure longer life... and trouble-free service. Let Pritchard skill and experience go to work for you on your next cooling tower job!

Write for Bulletins!



Cooling Towers
Gas & Air Treating
Specialized Heat Exchangers

Producers of QUALITY Specialized Process EQUIPMENT

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District Offices: CHICAGO • HOUSTON • NEW YORK • PITTSBURGH
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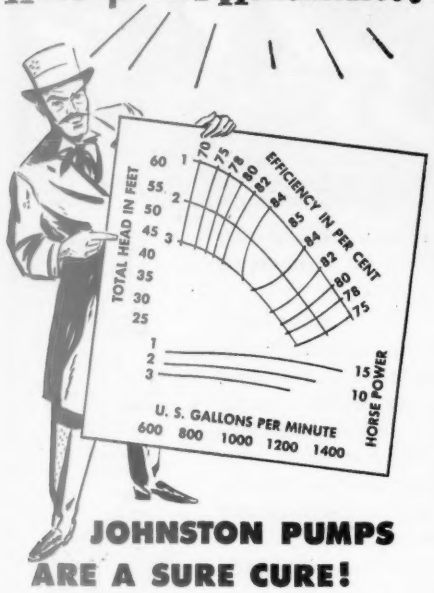
Suffering from
Horsepower Headaches?



JOHNSTON PUMPS ARE A SURE CURE!

Don't blow a fuse because you are overloaded with pumping troubles. The steep head-capacity and flat horsepower characteristics of Johnston Vertical Turbine Pumps prevent overloading of the motor regardless of fluctuations in capacity or head. Low starting torque requires less horsepower and results in higher efficiency and longer life of the motor.

The Treatment Is Painless

Every Johnston Pump is engineered for the specific duty for which it is intended. Trained hydraulic engineers are available at your nearest Johnston dealer or at the Johnston factory to furnish detailed information, proposals and anything else necessary to cure your particular pumping malady.

The Johnston Wonder Drug

Johnston Turbine Pumps are ideally suited for industrial and municipal applications because of their non-overloading characteristics, simplicity of construction, compactness, ease of installation, elimination of priming, low starting torque, capacity adjustment features and minimum maintenance costs.

Free diagnosis!

No matter what your pumping job, contact your nearby Johnston Dealer or write the factory direct for a free diagnosis of your pumping headaches.

JOHNSTON PUMP COMPANY
3272 EAST FOOTHILL BLVD., PASADENA 8, CALIF.
Headquarters for Vertical Turbine, Mixflow and Propeller Pumps Since 1909

Los Angeles Office Opened

Henry A. Ruysser, Jr., vice president and general sales manager of Black, Sivalls and Bryson, Inc., Kansas City, Missouri, has announced the opening of a BS&B Los Angeles office. Ross Baze,

Ross Baze

H. A. Ruysser, Jr.

named west coast sales manager, will be in charge of the Los Angeles sales office. Offices are at 1274 La Brea Avenue, Telephone Webster 1-17555. They will handle the complete BS&B line of oilfield products, safety heads and BS&B climax controls.

Baze, after graduating from the University of California with a degree in architecture, held a post in the University engineer's office. Later, he worked with the Pacific Telephone and Telegraph Company as a specification engineer, also spent two years with the Sinclair Prairie Oil Company designing plant layout and facilities.

Dowell Opens New Office

A new operating station in Williston has been opened by Dowell Incorporated. J. A. McClure, Dowell sales engineer from Salem, Illinois, is in charge of the Williston station. This new station has been established to offer fast, complete, and readily available acidizing, electric pilot and perforating services to operators in the Williston basin. McClure, a graduate engineer from Oklahoma A and M College in Stillwater, has been with Dowell since January, 1949. He will be assisted at the Williston station by R. L. Monfort, from Great Bend, Kansas.

Warner Lewis Expands

A plant expansion program involving new fabrication equipment and a new building has just been announced by the Warner Lewis Company. Construction has already begun on the new facilities across the street from their present location at 817 N. Lewis Place in Tulsa, Oklahoma. When the new buildings are completed, Warner Lewis will have almost 20,000 sq ft of shop space for fabrication.

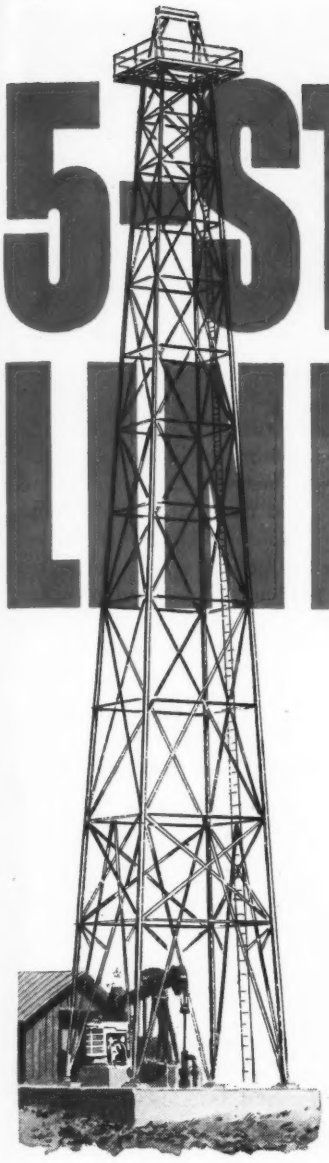
The expansion program has been sparked by numerous government contracts for Excel-So separators, dehydrators, filters, and proving tanks for Army and Navy use.

Oil Base, Inc., Appoints Rocky Mountain Agent

Thad Randolph, vice president in charge of sales, Oil Base, Inc., Compton, California, announces the appointment of English Oil Tool Company, Casper, Wyoming, as the exclusive distributor for sales and service of Black Magic, White Magic and other Oil Base, Inc., mud products, for the Rocky Mountain area. English Oil Tool Company is owned and operated by Glenn English. He is assisted by Don Rogers who is temporarily in Compton where he is undergoing complete training at Oil Base, Inc., on the use and maintenance of oil base drilling fluids, oil emulsion muds and additives.

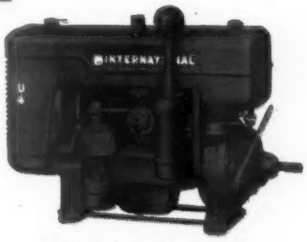
More than 1500 oil men gathered in Houston, Texas, recently to celebrate the official opening of new administrative headquarters of the Baroid Sales Division, National Lead Company. Guests attending the celebration were taken on guided tours of the new quarters. The new building contains extensive laboratory facilities for organic and analytical chemistry, mud analysis, and instrument design, complete photographic and printing facilities, and a technical library.

5-STAR LINE-UP



U-1, 10.5 A.P.I. max. hp.
at 1800 r.p.m.

U-2A, 21.8 A.P.I. max. hp.
at 1800 r.p.m.



U-4, 28.5 A.P.I. max. hp.
at 1800 r.p.m.

U-6, 37.5 A.P.I. max. hp.
at 1500 r.p.m.

U-9, 49 A.P.I. max. hp.
at 1500 r.p.m.

5 sizes of power
5 big reasons why

ADAPTABILITY—wide range of use, easily installed

ENDURANCE—proved by thousands of hours of dependable performance

ECONOMY—low-cost maintenance and repairs

SERVICE FACILITIES—all through the oil fields

REPUTATION—the International name and all it stands for

INTERNATIONAL HARVESTER COMPANY
CHICAGO 1, ILLINOIS

INTERNATIONAL HARVESTER

INTERNATIONAL

POWER THAT PAYS

To obtain more information on products advertised see page E-41

INCREASE PRODUCTION

WITH *Ledeen* CYLINDERS

Wherever you have to—

PUSH or PULL

LIFT or LOWER

PRESS or SQUEEZE

TILT or TURN

OPEN or CLOSE

Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen Cylinders are GOOD Cylinders

Write for Bulletin 500

Ledeen Mfg. Co.

1608 San Pedro

Los Angeles 15, Cal.

Canadian Oil Men and Guests. Flying to Canada from the annual API meeting in Chicago, Illinois, were Ideco's top executives who met with Canadian oil men in Calgary. Hosts were Ideco, Dresser Industries, Inc., and Dominion Oilfield Supply Company, Ltd. Front row: Bob Graves, Clark Bros.; Mrs. Gordon McKay, Mrs. Graves, Mr. and Mrs. Don Wilkin, Mrs. Jack Rauch, Mrs. Russell Wilson, Mrs. J. G. Smith, and J. G. Smith, of Dominion Oilfield. Back row: G. W. Walton, Ideco; Gordon McKay, Commonwealth Drilling; C. R. Athy and J. T. Alexander, Ideco; Jack Rauch, E. F. Shiels, Russell Wilson, Dominion Oilfield; J. B. O'Connor, Dresser Industries, Inc., and J. M. Cairns, Cairns and Howard Attorneys.

Tube Company Absorbed

The Babcock and Wilcox Tube Company, a wholly owned subsidiary of The Babcock and Wilcox Company, has been dissolved. The Tube Company's business and assets will be absorbed by, and it will be operated as, one of the divisions of The Babcock and Wilcox Company thereafter. Transfer of the plants and business of the Tube Company will have no effect upon its continued operation so far as the customers and employees of the subsidiary are concerned and will not change The Babcock and Wilcox Company stockholders' equities. The tube facilities will be operated as the tubuluar products division.

"Varec" Equipment Now Manufactured in France

Frank V. Long, Sr., president of the Vapor Recovery Systems Company, has announced the establishment by his company of a manufacturing affiliate in Paris, France. "Varec" products may now be purchased with French francs in France. The affiliated company is Compagnie Technique des Petroles with headquarters at 134 Boulevard Haussman, Paris, France. Zarry Toula, managing director of CTP has had wide experience for over 25 years in the actual construction and operation of oil refineries throughout Europe.

Cummins Men Tour Europe. L. W. Beck (right), who is vice president—sales of Cummins Engine Company, Inc., at Columbus, Indiana, and in charge of all domestic and export activities, and G. W. Glenn, vice president and general manager, Cummins Diesel Export Corporation (a wholly owned subsidiary), are shown reviewing their recent five-weeks' air trip to Europe where they talked with Cummins dealers and others in the heavy-duty machinery business about the prospects of diesel engine and diesel-powered equipment sales.

TRADE PERSONALS

Eli W. Parker has been appointed South Louisiana sales representative for Well Equipment Manufacturing Corporation. Parker has been engaged in oil field sales and service work since 1936 when he began with the production and drilling departments of The Texas Company in South Louisiana. In 1941 he moved to Houston as sales representative for a leading oil tool manufacturer, and later became associated with a major supply company as field representative for the Houston office. For the past three years, as service engineer for a drilling mud company, Parker has been designing mud systems for operators on the Texas and Louisiana Gulf Coast.

E. W. Parker

Harold F. Koons has joined Refinery Engineering Company, Tulsa, Oklahoma, as project engineer. The Refinery Engineering Company is engaged in the design and construction of oil refineries. Koons has been identified with the oil industry for the last 10 years. He spent over 7 years with Jones and Laughlin Supply. More recently, Koons has been employed as a Refinery Engineer with Derby Oil Company of Wichita, Kansas.

Dr. Henry C. Rosenberg has been added to the research staff of Dearborn Chemical Company, Limited, Toronto. Dr. Rosenberg was graduated from the University of Vienna in 1922. Until 1939 he was manager of Austria's largest industrial alcohol distilling plant. From 1939 to 1949 he was a member of the research staff of the International House of Trade and Commerce, Shanghai, working with hormones and glutamic acid derivatives.

Ernest L. Graves, formerly design section head engineer with Standard Oil Company (Indiana), has joined PAR Equipment, Inc., of Tulsa, Oklahoma, as chief engineer. Graves, who will specialize in application engineering, received his Bachelor of Science degree in mechanical engineering at Oklahoma University. He subsequently was associated with Shell Pipe Line Company and joined the Condit Company in Tulsa as sales engineer for two years. He rejoins D. J. Condit in the latter's newly formed organization, PAR Equipment, Inc., after one year with Standard of Indiana in Chicago.

E. L. Graves

John G. Nelson, assistant secretary and assistant treasurer of the American Steel and Wire Company, has retired after more than 42 years of service. Elected to succeed Nelson is **Don W. Ryan,** attorney on commercial matters in the company's legal department. After studying at Miami University and Case Institute of Technology, Nelson joined the Wire Company as a weigher at Newburgh Works, Cleveland, in 1909. In 1928 he was promoted to the post of assistant secretary and assistant treasurer, a position which he has held since then.

Ryan attended the College of Emporia, in Kansas, and he was graduated from Cleveland Law School in 1938. He first came to the Wire Company in 1941 as a member of the industrial engineering department at Cleveland Cuyahoga Works. In 1942 he was named assistant attorney in the legal department at the company's Cleveland offices. In 1947 he was appointed attorney-commercial matters, a position he has held since.

R. P. Parshall

H. L. Lurie

R. P. Parshall, former manager of the Milwaukee, Wisconsin, branch, Cummins Diesel Sales Corporation, Chicago, has joined the Cummins regional organization, as regional manager, Cummins Southeastern region; with headquarters at Atlanta, Georgia. Parshall has been associated with Cummins Diesel Sales Corporation for the past 5 years.

Harold H. Lurie, chief metallurgist, Cummins Engine Company, Inc., at Columbus, Indiana, has been named a member of a six man metallurgical advisory board to assist the United States Navy on a special technical project. A 1923 chemical engineering graduate of the University of Illinois, Lurie also holds a Master's degree from Purdue University. Before joining Cummins Engine in 1939, he was chief metallurgist for Ross Gear and Tool Company.

J. B. Allison has been named to head a new Merritt-Chapman and Scott Corporation office established in Dallas, Texas. The new office will serve as headquarters for the company's construction activities in the southwest and Gulf Coast areas. Allison is a graduate of the University of Texas.

C. E. Hendricks, formerly a director, as well as the vice president in charge of engineering at Century Geophysical Corporation, has announced his resignation to form his own organization for the maintenance, servicing, and repair of seismograph instruments and as consultants for engineering problems related to seismology. The new firm will be known as the C. E. Hendricks Company.

C. E. Hendricks

Joseph H. Humberstone, has been elected a vice president of Air Reduction Company, Inc. He was formerly the president of the company's Airco equipment manufacturing division and he has been succeeded in that capacity by **Scott D. Baumer.**

Ellis T. Beck is the new Eastern district manager of the Votator Division of The Girdler Corporation, Louisville, Kentucky. He succeeds Samuel Welch, who resigned on October 31. Beck, a native of Louisville, joined the Votator Division in 1948, following his graduation from the University of Kentucky. Prior to his assignment to the East he was a sales engineer in the fats and oils section, and has had wide experience in process and project engineering.

Edward Crossley Lipman, San Francisco business executive, has been named a director of Caterpillar Tractor Company, the company announced. Lipman was elected to fill the vacancy created by the recent death of Raymond C. Force at Oakland, California. The new board member, prominent in San Francisco business life, is president of The Emporium Capwell Company. He joined The Emporium in 1914, the year he was graduated from the University of California.

William J. McElroy has been named president of the West Coast Companies in the Round Associate Chain Companies group—Seattle Chain and Manufacturing Company, Seattle and Portland; Round California Chain Company, South San Francisco; Round Los Angeles Chain Company, Los Angeles. He will continue as general manager of Seattle Chain. He has been in the chain business since 1917, when he was appointed manager of the Virginia Chain Company in Parkersburg, West Virginia. Later he represented the Cleveland Chain and Manufacturing Company in New England and northern New York.

W. J. McElroy

▸ **R. M. Glover** of Du Pont's Wilmington, Delaware, sales office will become manager of the Mid-Continent district, at Tulsa, Oklahoma, January 1. **Charles D. Towery**, the present manager at Tulsa, will be transferred to Houston, Texas, as manager of the division's Gulf Coast district. **Alfred R. Mullis**, district manager at Houston, has been named manager of the Eastern district with offices in New York City. **E. Hearn Simpson**, acting manager of the Eastern district office, will return to Wilmington to resume his duties as sales manager of the Petroleum Chemicals Division.

Glover was employed by the Du Pont Company in 1947 as a salesman in the petroleum chemicals division, Wilmington office. Prior to joining Du Pont, he attended Rice Institute, being graduated in 1938, and was associated with Humble Oil and Refining Company, of Baytown, Texas.

Towery, a graduate of Texas A. and M. College, was with Bethlehem Supply Company of Houston prior to joining the Du Pont Company in 1947 as a salesman for petroleum chemicals.

Mullis has been with the Du Pont Company since 1947 as a petroleum chemicals division service representative in the Gulf Coast district. Following graduation from Rice Institute in 1938, he was employed in the research and development department of the Humble Oil and Refining Company.

So Light
AND
STRONG
BAKELITE VALVE DISCS
FRANCE ASBESTOS BAKELITE VALVE DISCS
assure these special features in compressor operation—higher strength and greater density than ordinary valve discs; light, strong with high fatigue resistance; impervious to corrosive action of many chemicals . . . Using France Bakelite Discs greatly reduces the cost of operation by increasing valve seat and disc life.
SPECIAL DISCS MADE TO ORDER.
A COMPLETE LINE
OF PACKINGS AND PISTON RINGS FOR INDUSTRY
FRANCE PACKING CO.
PHILA. 35, PA.
METALLIC PACKINGS
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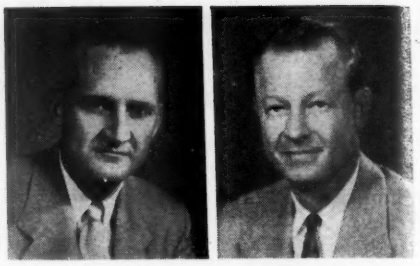
CARBON-BAKELITE LIQUID PUMP & COMPRESSOR PISTON RINGS
VALVE DISCS



C. Steinberger R. C. Macaulay

▸ **R. C. (Bob) Macaulay** has been promoted to vice president and general sales manager of Pacific Valves, with headquarters at the company's main office in Long Beach, California. He has been associated with the company for many years as sales manager—West Coast division. Replacing Macaulay as West Coast sales manager will be **John Gryson**, formerly sales engineer for Pacific Valves.

Chester (Chet) Steinberger has been appointed vice president and general manager of the Gulf Coast division of Pacific Valves, Inc. Steinberger has been associated with Pacific Valves for many years in charge of the Houston office. He will continue to make Houston, Texas, his headquarters, serving the greater Southwest area.

▸ **Luis E. Eckelmann,** manager of the Metal Finishing Division, has been elected vice president of the Pyrene Manufacturing Company, Newark, New Jersey. He will be in general charge of development work as well as of metal finishing. In April 1916 Eckelmann, while still a student at the Polytechnic Institute of Brooklyn, New York, joined Pyrene to do part time research, and following his graduation in June of that year, he became a full time member of the staff.

▸ **William A. Tinsler, Jr.,** has joined Dearborn Chemical Company, on the company's sales staff. Tinsler is a Purdue University graduate in chemical engineering, and served as an Ordnance specialist in the Navy during World War II.

Prior to his addition to the Dearborn sales staff, he was engaged in research development and in corrosion engineering.

▸ **A. C. Polk, Jr.,** assistant manager of Dowell Incorporated, has been named general manager of Dowell. The new general manager is also a member of the board of directors, and has been with Dowell since July, 1941. Polk, before his promotion to assistant manager in 1948, was stationed in the Houston district as district manager. He attended college at Rice Institute and the University of Oklahoma.

A. C. Polk, Jr.

J. J. Merkel and **E. E. Klemm** have been named branch managers of the Quaker Rubber Corporation's Detroit, Michigan, and Cleveland, Ohio, districts, respectively. Quaker Rubber is a division of the H. K. Porter Company, Inc., Philadelphia, Pennsylvania. The men will assist their respective district managers in the operation of the sales office and warehouse.

Merkel, a former student of Detroit Institute of Technology and Wayne University, joined Quaker in 1948. Klemm has been a salesman for Quaker for more than three years. He is a graduate of Baldwin-Wallace College.

Carson L. Ruyle has been appointed advertising manager of the Gardner-Denver Company, Quincy, Illinois, according to a company announcement. Ruyle assumes the position formerly occupied by Lt. Damon P. Tunnicliff, who has been called to active service in the Navy and who is assigned to the Destroyer U.S.S. Power for duty in the Newport, Rhode Island area. He has been advertising manager of Gardner-Denver for the past five years. Ruyle joined the Gardner-Denver Company in 1930.

A. B. "Burm" Winter is now assistant chief electrical engineer for the Lane-Wells Company at Los Angeles. In this capacity, he will be concerned with specification, design, and completion of electrical phases of Lane-Wells equipment, along with the acquisition, installation, and maintenance of it. He will also be concerned with the investigation of operating problems and recommendation of changes, corrections, inspection, and testing of electrical equipment. Winter has been with Lane-Wells for 17 years.

A. B. Winter

Milo M. Hawthorne will take over the position vacated by Winter at Houston. In this capacity, Hawthorne will supervise all division radioactivity equipment and will assist in the selection and training of radioactivity personnel. He will assist the sales department in the technical aspects of radioactivity. Hawthorne came to Lane-Wells in 1947 as a rigman.

DEATHS

I. H. Grancell, founder and head of the company of the same name, died suddenly at his home in Los Angeles on November 1. He was 73 years of age. As developer and manufacturer of Bestolife Tool Joint and casing compounds, Grancell was a well-known and familiar figure in the oil country for more than 20 years. The business will be continued under the present management, headed by Mrs. Grancell. There will be no change in company policies.

Donald W. Tait has been appointed advertising manager for the Perlite division of Great Lakes Carbon Corporation it was announced by Donald H. Gott, general sales manager, building products.

With headquarters in the company's executive offices in New York, Tait will be in charge of all advertising matters concerning Permalite plaster and concrete aggregates, Strata-Seal, Strata-Crete, and other expanded perlite products. These products offer the advantages of light weight, insulated, fireproof, and crack-resisting construction.

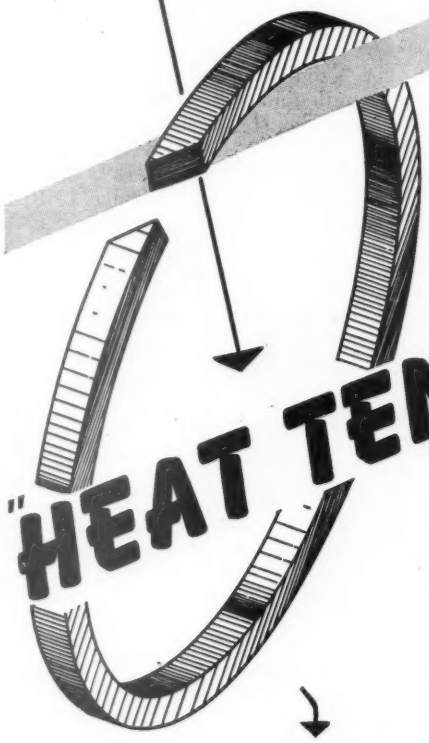
Tait was formerly associated with the Chase Brass and Copper Company at Waterbury, Connecticut.

Joseph H. Lancor, Jr., has been named director of the transducer division of Consolidated Engineering Corporation In his new position, Lancor will supervise and direct the design and development of transducers of various types including vibration pick-up, accelerometers and pressure pick-up. He was formerly director of product engineering of Vitro Corporation. The appointment was announced by Phillip S. Fogg, president.

P. S. Fogg

INDUSTRIAL PACKINGS FOR MORE THAN 50 YEARS

FRANCE Piston Rings are "HEAT TENSIONED"



You require Piston Rings that last longer. France Power Piston Rings are centrifugally cast as well as "HEAT-TENSIONED". These features assure you remarkable wearing qualities, correct uniform radial pressure without loss of tension or warpage in service . . . CRIMPED STEEL EXPANDERS for all types of Oil Rings.

WRITE FOR '51 CATALOG

FRANCE PACKING CO.

PHILADELPHIA 35, PA.

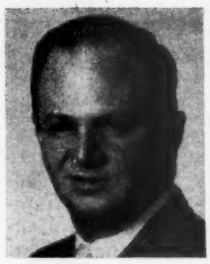
METALLIC PACKINGS | POWER PISTON RINGS | CARBON-BAKELITE LIQUID PUMP & COMPRESSOR PISTON RINGS | VALVE DISCS

▸ **James H. W. Conklin** has been appointed general sales manager of the Philadelphia Division, Yale and Towne Manufacturing Company. Conklin succeeds **James P. Kinney** who is taking over Yale and Towne's distributorship in Los Angeles and southern California. Conklin has had considerable experience in materials handling—for several years prior to this he was sales manager of the industrial truck division, Clark Equipment Company.

J. H. W. Conklin

▸ **Daniel J. Duffin** has been appointed to the public relations department of American Locomotive Company. Formerly acting public relations director at Foster Wheeler Corporation in New York, Duffin came to Alco from Unified Promotion Advertising, Inc., New York. He served as an editor and writer of technical books from 1945 to 1949 with McGraw-Hill Book Company, Inc., Thomas Y. Crowell, Pitman Publishing Company and Harper and Brothers. Among books he has written or co-authored are "Steam Power Plant Auxiliaries and Accessories," "A History of Radio and Television," and "Generators and Motors and Their Applications." He was an Army captain in World War II.

▸ **Charles Smith** has been named manager of the A. O. Smith Corporation product service division at Chicago, succeeding **J. W. Spoor,** who was named general sales manager of the company's welding products division.


Charles Smith

P. H. Fahrer

George Carlson

P. H. Fahrer, former manager of the Los Angeles product service branch, moves to Chicago as Smith's assistant. Succeeding Fahrer as Los Angeles manager is **George Carlson,** formerly assistant of the Union, New Jersey, branch.

Smith joined A. O. Smith in 1941 at Milwaukee. He was transferred to product service in 1946 to head the field service activities there. Mr. Fahrer has been with A. O. Smith since 1948. He became Los Angeles product service manager in 1950. Carlson moves into his new post at Los Angeles after having had experience in the A. O. Smith stoker division and market research departments.

▸ **James S. Anderson** who has been on leave from The Babcock and Wilcox Tube Company, has returned to his duties as assistant general sales manager with the Tube Company. Anderson has been in Washington serving as chief of the tubing section of the iron and steel division of the Industries Operations Bureau of the National Production Authority since April, 1951.

▸ **Alan C. "Al" Tracy** has been appointed manager of the new Pacific Coast sales office opened recently by the Charles Wheatley Company in the Tilden Sales Building, San Francisco, California. Tracy was formerly sales manager of Petroleum Equipment Company in San Francisco and was also with the sales department of the Marshall-Newell Supply Company.

A. C. Tracy

With the opening of this office, the Wheatley Company also announces its appointment as exclusive sales representatives in the Pacific Coast area for Wheatley pumps and parts.

WATER

FROM THE GROUND BELOW YOU

IN single or multiple units, Layne well and pump installations produce tremendous quantities of water at extra low cost. High efficiency designing, precision building and advanced methods of installation make Layne wells and pumps a highly practical and fully justified investment. Layne does the job complete; drills the wells, furnishes all casing, shafting, pumps, motors and sand screen. After complete testing, the system is delivered to you in perfect operating order.

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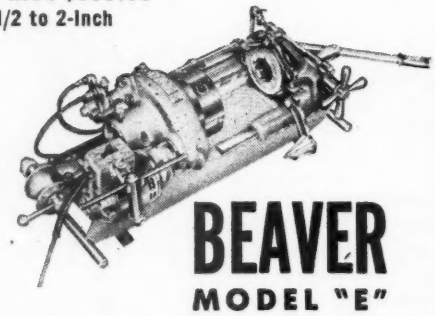
Layne **WATER SUPPLY WELLS & PUMPS**

PRICE $385.00
1/2 to 2-Inch



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MODEL "E"
pipe and bolt machine

● Cuts, threads and reams all kinds of pipe from ⅛ to 2-inch. With a drive shaft and geared tools cuts and threads pipe up to 8-inch. Cuts off bolts and rods up to ⅞-inch. Threads bolts and rods to 1½-inch in one cut; up to 2-inch in two cuts.

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"Over 50 Years of Friendly Service"

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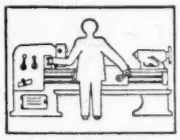
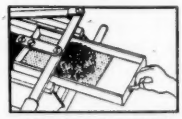
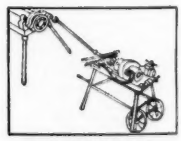
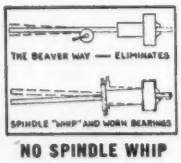

RIGHT-HANDED

GEARS RUN IN OIL

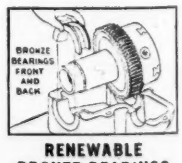

HANDY CHIP TRAY


RUGGED STAND AVAILABLE



NO SPINDLE WHIP

SAFETY SWITCH LOCK



RENEWABLE BRONZE BEARINGS

Charles E. Nelson, Jr., has been elected director of Waukesha Motor Company. Also vice president, production, Nelson entered Waukesha Motor organization in 1929 following several years as state wholesale representative for a major motor car manufacturer. His earliest activities with the company were connected with the financial department and led to his appointment in 1933 as secretary and treasurer of the Fageol Truck and Motor Coach Company of Oakland, California, at that time a subsidiary of the Waukesha Motor Company. Returning to Waukesha in 1934, he became factory production manager and in 1936 was made director of purchases and production planning. In 1947 he was appointed assistant to the president, and in February 1949 he was appointed vice president in charge of production.

C. E. Nelson

Walter Buehring, former district manager in the New Iberia area, Waukeshe Sales and Service, Inc., has been named to the newly created position of service parts manager. It will be the responsibility of his department to maintain adequate service parts stocks in all branches. **H. N. Carter,** former branch manager in the Corpus Christi area, will be assistant service parts manager.

J. B. Krenek, former branch manager of the Waukesha Kilgore store, has been named district manager of the New Iberia territory. **M. D. Russell,** former parts manager in the Kilgore store, has been promoted to branch manager to succeed Krenek.

In other changes, **Frank Williams,** former sales engineer, was promoted to district manager in Houston. **G. C. Shows** was promoted to branch manager in Houston. New sales engineers added to Waukesha Sales include **Leon Miller,** sales engineer for the Pampa, Texas, area; **G. C. Sies,** sales engineer, Odessa; **Harry Goss,** sales engineer, Houston; and Bert Coleman, sales engineer, Houston.

Raymond E. Olson has been elected president of the Taylor Instrument Companies. He succeeds **Lewis B. Swift** who was named chairman of the board. Olson joined the firm in 1917. He is also a vice president of Taylor Instrument Companies of Canada Limited.

R. E. Olson

Olson brings to the presidency of this century old firm a wide experience in engineering, sales, and administration. He is credited with 23 patents, 13 of them in the dairy instrument field. His predecessor, Lewis B. Swift, took office in 1938.

R. F. Davis, former assistant regional manager, Cummins central region, with headquarters at Chicago, Illinois, has been promoted to regional manager, Cummins eastern region, with offices in the Chrysler Building, New York City. Davis has been employed by Cummins since the spring of 1942. He first served as an inspector on the Cummins production line, and in 1944 was transferred to the Cummins purchasing department, where he became a field expediter. In 1948 he joined the Cummins regional organization. **Walter N. Westland,** former regional manager, Cummins Eastern region, now heads Cummins Diesel of New England, Inc., with headquarters at Allston, Massachusetts.

R. F. Davis

J. Robert Simpson III, has been named a new associate of J. R. Simpson & Company, Chicago, Illinois, bringing with him five years of seasoned experience as sales enigneer for Conoflow Corporation. Simpson will join his father as a partner in the Chicago firm, where he will continue to be engaged in the application, engineering, and selling of Conoflow prenumatic control equipment. Simpson and Company are representatives of Conoflow Corporation, Philadelphia.

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THEY ARE USED FOR THE CONTROL OF TEMPERATURE, PRESSURE, LIQUID LEVEL AND MECHANICAL OPERATIONS.
THE MERCURY SWITCH IS A FEATURE IN MERCOID CONTROLS. THE REASON FOR THE MERCURY SWITCH IS THE ADDED SAFETY-BETTER PERFORMANCE AND LONGER CONTROL LIFE-ALL OF WHICH ARE IMPORTANT WHEREVER CONTROLS ARE REQUIRED.
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4201 BELMONT AVE. CHICAGO 41, ILL.

The Beautiful
RICE HOTEL
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Next time you are in Houston, make your home at the friendly, comfortable Rice, where heart-of-Houston location means greater convenience to you. Beautiful new PETROLEUM CLUB on entire top floor.

RATES FROM $4.00 SINGLE AND $6.00 DOUBLE

HOME OF THE FAMED *Empire Room*

NOW MORE THAN EVER BEFORE
"Houston's Welcome to the World"

BOOKS

Patents for Technical Personnel, *by Dr. Worth Wade. Published by Chemonomics, Inc., 400 Madison Avenue, New York, N. Y. Price, $3. Pages, 44.*

This book is a handbook on patents, their development and current practices, discussing what a patent is, and the steps that must be taken to protect an invention. Written for the inventor and the employee of a chemical process plant, this book clearly analyzes the contents of a patent, and presents a systematic method for analyzing and checking claims.

POSITIVE OIL SHOW IDENTIFICATION with MINERALIGHT Ultra-Violet

(BLACK LIGHT)

Make sure you don't pass up possible pay! Make positive core identification checks with new model MINERALIGHT SL long wave ultra-violet lamp.

Proved best by test for oil show analysis!

No experience needed to operate. Lamp weighs only 1 lb. Models available for 110 volt AC or with adapter, 110 volt DC current. Battery operated model for field use holds lamp, has built-in viewer for daylight examination. Easily portable.

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Send for illustrated brochure on how to detect and analyze petroleum in oil surface samples with ultra-violet.

ULTRA-VIOLET PRODUCTS, INC.

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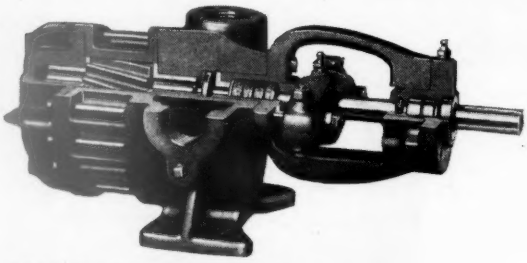
ROPER ROTARY PUMPS

The Name of Dependability



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ASTM Standards on Petroleum Products and Lubricants, *prepared by Committee D-2. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Price, $5.75, paper. $6.40, cloth. Pages, 804.*

This 1951 compilation brings together in compact form most of the standards, test methods, and specifications widely used in the petroleum industry. This edition gives: Latest test methods; seven specifications; 1 classification, three lists of definitions relating to the petroleum industry, specific gravity, and rheological properties of matter, and two tentative recommended practices for the purchase of uninhibited oil for use in transformers and in oil circuit breakers.

Included also are standard specifications for ASTM thermometers as well as test methods for: Total inhibitor content of butadiene; bromine number of petroleum distillates reduced pressure distillation of petroleum products; and hydrocarbon waxes used in electrical insulation.

Oil and Gas Federal Income Taxation, *by Kenneth G. Miller. Published by Commerce Clearing House, 522 Fifth Avenue, New York 18, N. Y. Price, $7.50. Pages, 274.*

For anyone interested in oil and gas federal taxation problems, this second edition will provide much information. This newly released book brings together the up-to-date data on law, regulations, rulings, and decisions of federal income taxation as they apply to the peculiar factors of the production side of the oil and gas industry.

In it are discussed: Depletion; time for depletion deduction; cost depletion; economic interest; gross income for the property; net income from property for depletion purposes; interests in oil and gas place bonus; lease, sublease or sale; intangible drilling and development costs; lease costs; special problems affecting drilling contractors; associations taxable as corporations, and many more.

Spindletop, Where Oil Became an Industry, *published by the Spindletop Fiftieth Anniversary Commission, Box 3150, Beaumont, Texas. Price, $3. Pages, 201.*

The observance of the 50th anniversary of Spindletop, official proceedings of which are contained in this book, was the result of planning and work. The primary significance of the Lucas Gusher was the fact that for the first time American industry was assured a sufficient supply of petroleum for use in her industry. The 50th Anniversary Commission chose this as a symbol of American free enterprise, and planned the celebration which followed. The entire meeting is recorded and illustrated in this book.

Geology and Ground-Water Resources of San Miguel County, New Mexico, *by R. L. Griggs and G. E. Hendrickson. Published by New Mexico Bureau of Mines and Mineral Resources, Socorro. Pages, 117.*

This report describes the occurrence and availability of ground water in San Miguel County and the geology of the county in relation to the occurrence of ground water. Topographically, San Miguel County includes the plains, Las Vegas Plateau, Glorietta Mesa, and the Sangre de Cristo mountains. The book includes the subjects of geology, ground water, future possibilities of ground water, summary of availability, and a bibliography. Also included are two maps showing the geology of the county and the locations of wells and springs and the availability of ground water.

Oil and Petroleum Year Book, *compiled by Walter Skinner, 20, Copthall Avenue, London, E.C. 2, England. Price, $4. Pages, 278.*

The 42nd year of publication for this standard reference work contains particulars on 762 companies operating in all parts of the world. A list of names of 492 managers and engineers and the companies with which they are connected is given. American and foreign companies are fully detailed. The particulars of each company include: Names of directors, and other officials, description of business, where operating, crude oil production, refinery runs, details of capital, dividends, and financial results. The Buyer's Guide of Manufacturers of oilfield and refinery equipment comprises 705 headings.

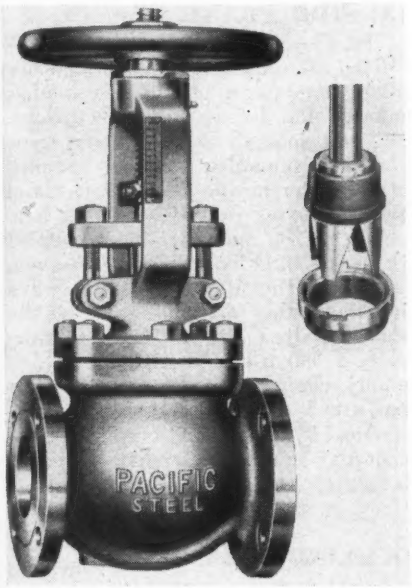
New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

(A) GLOBE VALVES

Pacific Valves, Inc., has announced a new "V" port, globe valve. This valve is of the conventional type O. S. and Y..



bolted bonnet globe valve with a special disc designed to carefully regulate the flow through four "V" shaped ports. These valves are cast carbon steel regularly supplied with 12 per cent chromium stainless steel trip. An indicator is provided to accurately adjust the flow, and to tell position of disc at a glance.

Circle letter (A) on reply card.

(B) PROCESS CONTROL UNIT

A new miniature all-electronic process control unit is announced by The Swartwout Company. Known as the Autronic control system for use in chemical and food processing plants, refineries, petrochemical installations, central stations, and industrial power plants.

Featuring complete electronic operation, the Autronic controller has no moving parts, slide wires, or boosters to initiate control action. Because transmission of information throughout the system is by electrical means only, response is instantaneous. There are no connecting air lines between units to cause transmission lags.

Circle letter (B) on reply card.

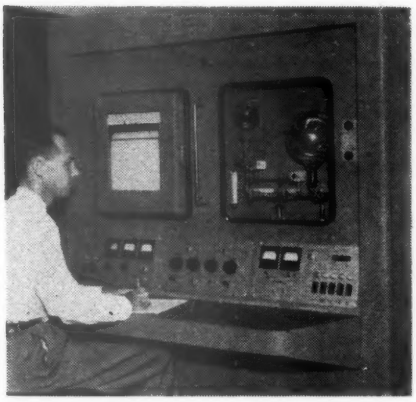
(C) POLYETHYLENE VALVES

American Agile Corporation, offers 1 and 2 in. bore valves that are fabricated throughout from polyethylene, except for the packing rings, made from a polyethylene - polyisobutylene mixture. These valves, known as Agilene valves, are extremely light in weight (1 lb and 3¼ lb respectively) and are highly resistant to most corrosive chemicals including hydrofluoric, sulfuric, nitric, and hydrochloric acids at temperatures up to 170 F. Agilene valves are supplied with standard drilled flanges for easy incorporation into existing installations or for use in new pipe line assemblies, the manufacturer states.

Circle letter (C) on reply card.

(D) MASS SPECTROMETER

A new model has been added to the line of mass spectrometers manufactured by Consolidated Engineering Corporation of Pasadena, California. This new instrument, the Model 21-401, is a dual-purpose mass spectrometer de-



signed for the analysis of mixtures of gases and light liquids, as well as for determination of ratios of stable isotopes. It will fill a particular need in laboratories having moderate analytical loads of a routine nature and be valuable in research and exploratory applications involving both mixture analysis and stable isotope tracer techniques. The complete elimination of refrigerants, such as liquid nitrogen, will result in a reduction of operating costs to the user. Numerous automatic devices serve to minimize operator errors and effect a saving in the time required for analysis.

Circle letter (D) on reply card.

(E) PIPE FITTINGS

Key Company has announced the development and production of a complete line of "Key-Kast" alloy steel welding

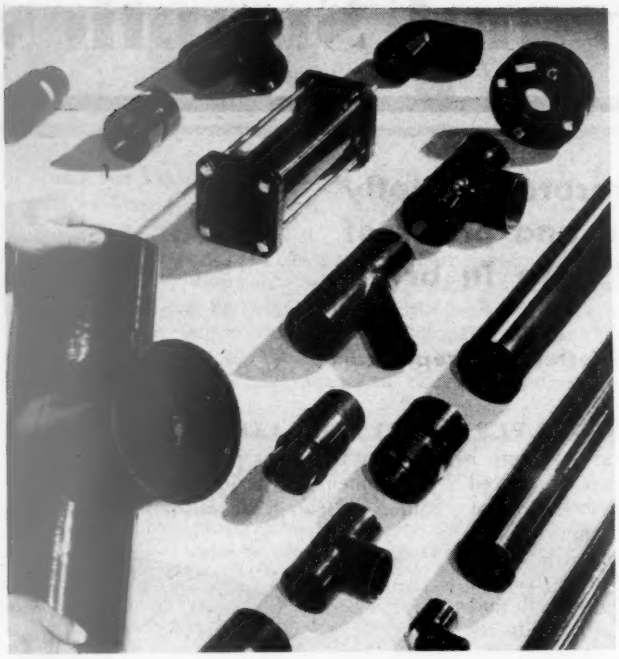
pipe fittings and flanges. Based on a new design of greater wall thickness throughout and added thickness at areas of stress, the company states its new line provides a stronger fitting and gives longer life to piping systems at a lower unit cost. The new Key-Kast line of alloy welding fittings and flanges is available in all sizes and schedule numbers through local suppliers.

Circle letter (E) on reply card.

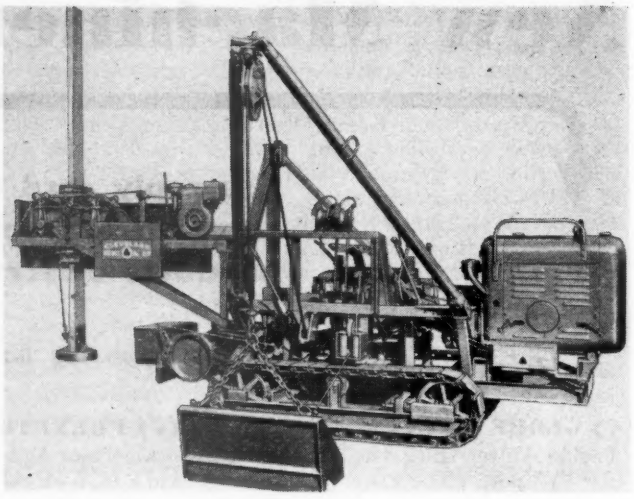
(F) DIESEL ENGINE STAND

A new All-Kleer diesel engine stand, manufactured by the R and G Manufacturing Company has been announced. Claimed to be the most convenient engine stand ever devised, the All-Kleer is entirely different in that it engages the diesel heads from the side and does not block cleaning or other work on the manifold ends. The diesel head is grasped firmly in a non-jiggling grip by four adjustable engaging pins that fit into the head bolt holes and lock into place. Loosening or tightening of the All-Kleer's handy pressure brake permits rotation of the engine head to practically any angle for most convenient and speedy servicing. A sub-assembly adapter is available to fit the All-Kleer, permitting the operator to also service small diesel assemblies such as governors, fuel pumps, and similar items. Other features are heavy duty rollers, removable drip pan, and tool pan.

Circle letter (F) on reply card.



Tennesse Eastman's noncorrodible pipe fittings.



Cleveland Trencher crane which does all types of crane work.

(G) PIPE FITTERS

Noncorrodible pipe fittings for the oil fields are fabricated from durable Tenite plastic, the same material now widely used for oil field piping. Threaded or slip-sleeve, the fittings are produced in a great variety of sizes and shapes. Slip-sleeve couplings can be quickly installed, permanently bonded, in Tenite lines by use of a cement and thinner having an affinity with the plastic. Installed, these long-wearing Tenite parts prove exceptionally resistant to weather and soil conditions. The lightweight and high impact strength of Tenite make the fitting easy to handle. Tennessee Eastman Company.

Circle letter (G) on reply card.

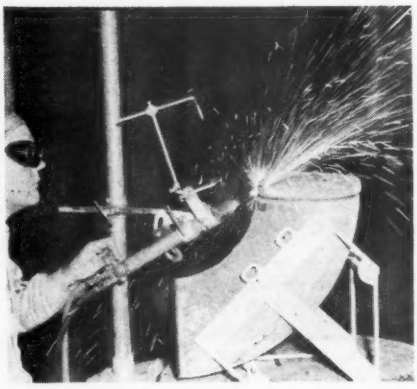
(H) METERS

Beckman Instruments, Inc., has recently announced development of new battery-operated pH instrument incorporating a number of revolutionary advancements that insure greater convenience and all-around adaptability in plant and field applications. Known as the Beckman Model N pH meter, this new instrument is light in weight, unusually compact. The complete instrument measures only 4 by 6 by 9½ in. overall, including built-in power supply, and weighs less than 8 lb complete. The electrode support is mounted on the side of the case so that it can be easily rotated to permit the instrument to be used in either a horizontal or vertical position—whichever is most convenient. The electrodes plug-in directly to the side of the instrument case, permitting quick interchangeability of electrodes. Furthermore, the electrodes are practically unbreakable, cover virtually the entire pH range from 0 to 14, and can be safely used at temperatures ranging from freezing to boiling.

Circle letter (H) on reply card.

(I) BEVELING MACHINE

Used welding fittings are reclaimed as new by the use of a beveling machine developed and patented by Az Nu, Inc. This service should be of particular interest to the petroleum and chemical industries because of the present shortage of this critical material, and the savings effected. All fittings are restored to the original factory dimensions when they are received with at least ⅛-in. of pipe beyond the weld. Fittings received for contract beveling are first stamped with the owner's code number, then cleaned in a chemical solution to remove oil, paint, scale, etc. Next they



are checked for length and their grade designated. They are then beveled, the remaining weld deposit is ground off using Az Nu grinding machine, then checked for tolerance and painted. A complete reclamation service is offered for all flanges. Welding neck, slip-on and various other types, in both flat face and ring joint, are beveled and the face machined if necessary.

Steel screw flanges may be reclaimed as such or converted to slip-on flanges. Female flanges may be converted to male.

Circle letter (I) on reply card.

(J) SIDE CRANE

The Cleveland Trencher Company's "Model 80" is a one-man-operated machine that tamps, backfills, lays pipe, unloads and handles pipe, sheathing, etc., and does all types of light crane work. The versatile machine is mounted on a crawler having 24 separate travel speeds, ranging from one foot per minute up to 2⅛ miles per hour, coupled with high stability and utmost maneuverability. The Model 80 tamps while traveling either along the side of the trench or straddling it. The tamper delivers a 380 ft-lb blow, 45 times each minute, compacting the earth in layers that are 3 to 4 times thicker than is practical by air or hand tamping. Pavement may be relaid immediately without danger of settling.

Circle letter (J) on reply card.

(K) LINE STRAINER

The Universal Valve Company has announced the development of a 1½-in. suction line strainer that will fit a 2-in. tank opening. It is intended for use in pump suction lines, and is so designed that the liquid must enter from the sides instead of the bottom. This feature does not trap water and keeps the line free from foreign matter and sediment while permitting maximum flow. Known as the 611G, the new suction line strainer will reduce repair costs by enabling the use of a 2-in. tank opening.

Circle letter (K) on reply card.

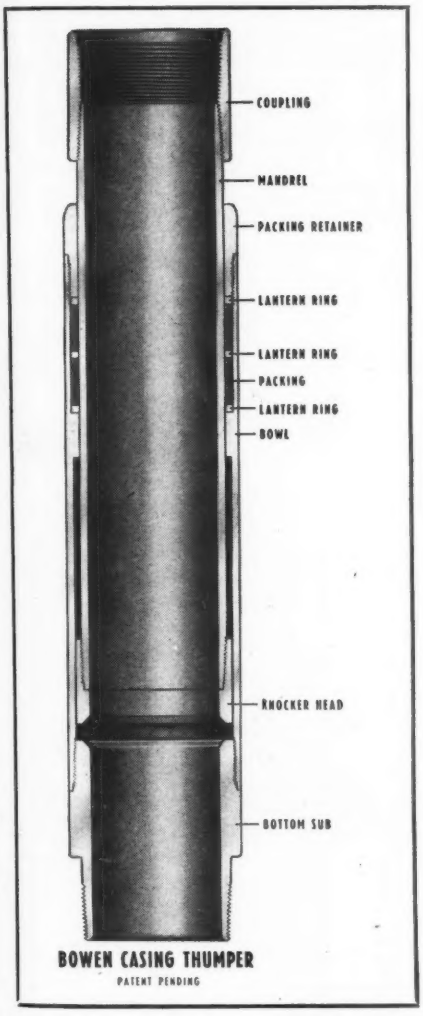
(L) CONTROL PANELS

Industrial Control Panel Company has announced a new close differential a-c device, used only in Pantro automatic load transfer control, which makes it possible for the load to operate on under-voltage. This device prevents chatter and undue contact wear. Pantro control panels are custom-built and assure continuity of power supply and maximum engine running time on a given amount of fuel. All units are mounted to make them readily accessible for quick, easy inspection, and servicing.

Circle letter (L) on reply card.

(M) CASING THUMPER

The Bowen casing thumper has been developed for landing casing in slant holes or tight holes. Experience with such holes has shown that in many instances it is impossible to land the casing by simply lowering it into the hole. The Bowen casing thumper provides the additional force required to drive the casing down the hole. The mandrel and bowl are free to move longitudinally a limited amount in relation to each other, and are packed off to prevent fluid leakage from either internal or external pressures. The coupling of the tool is

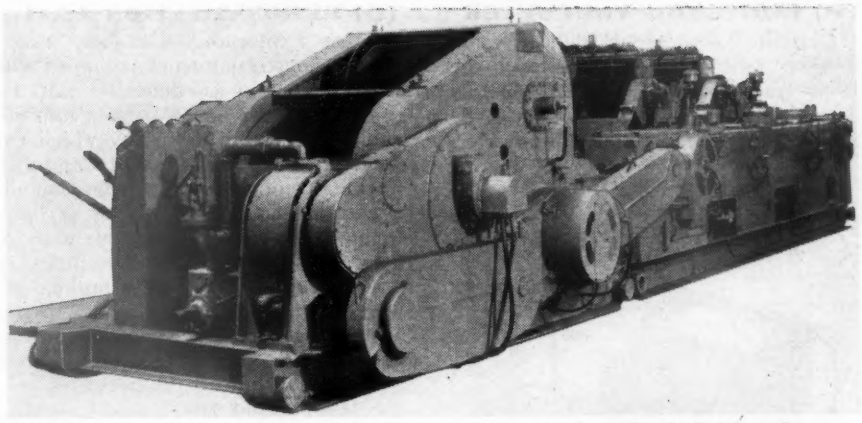


BOWEN CASING THUMPER
PATENT PENDING

smaller in diameter than the bowl, insuring the ability to strike blows should the bowl stick. All types of "inside the casing operations" can be conducted after the string is landed because the bore through the thumper corresponds with the internal diameter of the casing. Because it is practically impossible to rotate casing in deep, slant holes, the most widely used Bowen casing thumpers are not designed to transmit torque. Some types are splined for transmission of torque.

Bowen casing thumpers are also used to drive long liners to the desired depth in slant or tight holes. In thumpers used for this purpose, the packing elements are usually eliminated. The S. R. Bowen Company.

Circle letter (M) on reply card.


IDECO's new addition to its Hydair torque converter and mechanical drive rigs.

(N) DRILLING RIGS

IDECO recently introduced two new rigs in the 750 hp class to their line of Hydair torque converter and mechanical drive rigs. Designed for two or three-engine application the 750 series introduces a unique conversion feature. The mechanical drive model 750 rig can be converted at any time from mechanical to torque converter drive. This conversion is accomplished by equipping the M-750 with high speed engines and torque converters, changing one sprocket, and modifying the air control system. This feature enables the operator to use his existing low speed engines, and at a later date modernize the rig.

Circle letter (N) on reply card.

(O) LIFT UNIT

The Lug-All Company has announced a new 6-lb accessory for lifting of pipes, motors, unit heaters, or construction equipment. This device is especially useful for pulling up broken overhead conveyor chains. Operation is normally from the ground. Only the 6-lb Longlift need be taken up the ladder for overhead suspension. Capacity is 750 lb, and minimum distance between hooks is only 10 in. Especially designed for the Longlift is the 8½ lb Lug-All winch-hoist, but any hoist with a minimum lift of 15 ft may be used. This accessory has increased usefulness of Lug-All winch hoist.

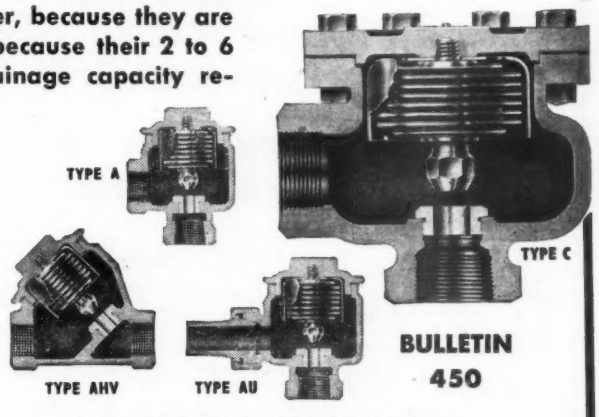
Circle letter (O) on reply card.

NICHOLSON MAKES

Freeze-Proof Steam Traps

for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Sizes ¼" to 2"; pressures to 225 lbs.



BULLETIN 450

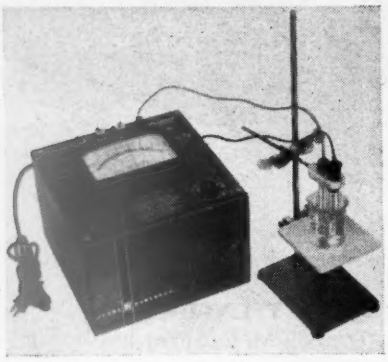
217 OREGON ST., WILKES-BARRE, PA.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

(P) INDICATOR VOLTMETER

New line-operated pH indicator and vacuum tube voltmeter developed by Leeds and Northrup, is unaffected by normal fluctuations in line voltage or by zero drift of the amplifier. A converter-



type instrument, its circuit employs D-C to A-C conversion, A-C amplification, and conversion back to D-C for voltage feedback. Conversion stabilizes zero; feedback stabilizes gain. Used as a pH indicator, the instrument reads directly in pH; makes glass electrode measurements to within ± 0.02 pH on grounded or ungrounded solutions. As a vacuum tube voltmeter, the new indicator can be used with any high or low impedance electrode system which develops potentials within range of the instrument.

Circle letter (P) on reply card.

(Q) DEMONSTRATION UNIT

Atlas Exploration Company has a field demonstration truck equipped with various types of gas detecting units for use in preventing explosions in industry and a calibrating device by which gas detectors can be calibrated under actual working conditions. Instruments include a portable model Probetector, a lightweight, portable unit commonly used for determining explosive possibilities of gases in any location by sampling gas with a special probe-head; an alarm model; a model for retecting hydrocarbons on drilling rigs for use of geologists and safety engineers; a model for testing drilling mud samples, and a model for detecting gases on boats. Demonstrations are being given throughout the Gulf Coast in the petrochemical industry.

Circle letter (Q) on reply card.

(R) HEAT MACHINE

A new 140,000 BTU heat machine for indoor or outdoor use is announced by Fageol Heat Machine Company. Known as the Fageol Model PW-140, the machine is reputed to employ an entirely new principle of forced-air circulation and to "heat men at work—not empty spaces." The manufacturer states that by blowing warm air out of the machine's base along the floor, it creates a 6-foot-high heat blanket and eliminates the necessity for heating vast overhead areas in order to keep workers comfortably warm. This concentration of heat is said to reduce heating costs by as much as 90 per cent. The Model PW-140 sprays heat from all sides across the floor. Consequently, it can be advantageously situated in the center of large areas. The Model PW-140 is designed to comfortably heat workers in areas up to 3000 sq ft of confined space.

Circle letter (R) on reply card.

(S) FILTER PRESS

A new API-type tester is being manufactured by Oil Base, Inc. It will be known as the OBI filter press. Special features were developed and patents are pending by California Research Corporation, a subsidiary of Standard Oil of California. Chief advantage of the OBI filter press lies in its ability to measure accurately the filter losses of drilling fluids having very low loss. The bottom cell is so constructed that the small holdup volume (0.08 ± 0.03 c.c.) is almost negligible as compared with a

holdup volume of 1.0 c.c. or more, encountered in the standard API tester, which does not measure fluids with losses of 1 c.c. or less. Should present methods of evaluation be desired, however, the OBI filter press can be converted by simply inserting a monel screen into the bottom cap.

Circle letter (S) on reply card.

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Durametallic Packings

✓IS IT LUBRICATED THRUOUT - AND WEARS LIKE A BEARING ?	Yes
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✓ARE THERE TYPES AND STYLES FOR SEALING SPECIFIC CONDITIONS ?	Yes
✓IS IT ECONOMICAL - CAPABLE OF LONG UNINTERRUPTED RUNS . . . ?	Yes

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Trade Literature

Publications will be sent free.

(T) INJECTION SYSTEM

Black, Sivalls and Bryson, Inc., announces the publication of a 12-page bulletin on its new glycol injection system. Attractively printed in two colors, the contents are arranged for easy reading, written in non-technical language, and fully illustrated with diagramatic drawings and charts. The BS&B glycol injection system is a low temperature separation process with an inhibitor added to prevent hydrate formation. The system allows full use of refrigeration by expansion to produce lower separator temperatures and lower dewpoints of the gas stream than conventional low temperature separation units. This is said to bring higher recovery, longer life, greater salvage.

Circle letter (T) on reply card.

(U) CORROSION CONTROL

D. W. Haering & Company, Inc., Water Consultants, announces that a limited supply of the 1952 H-O-H calendar, featuring a four-color Light-house scene, is now available for distribution. The company also advises that their 44-page book, "Organic Methods of Scale and Corrosion Control" with valuable charts and data may be obtained by making your request on company letterhead.

Circle letter (U) on reply card.

(V) CONTROLLERS

A 4-page bulletin published by Minneapolis-Honeywell Regulator Company describes the company's Tel-O-Set controllers, which are function designed for control of process variables, such as temperature, pressure, flow, and liquid level. The units are easily installed, and compact. They have instant response to process change, and a pneumatic-balance principle of operation that eliminates lost motion and reduces friction to a minimum.

Circle letter (V) on reply card.

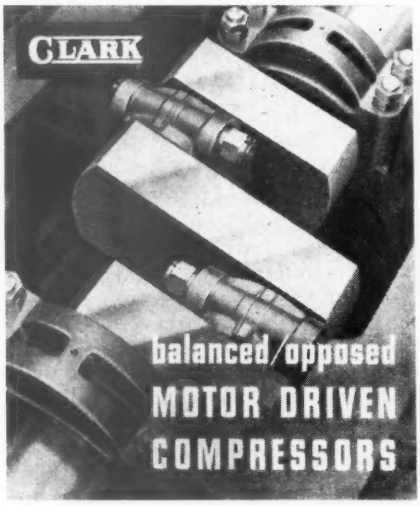
(W) DIESEL ENGINES

A booklet entitled "What Do GM Diesels Do?", which describes the many uses diesel engines fulfill in our modern economy has just been reprinted by Detroit Diesel Engine Division of General Motors. This entertaining and instructive booklet is written in rhyme and is illustrated by drawings of locomotives, busses, boats, power shovels, saw mills, and many other pieces of essential equipment that are today commonly powered by diesel engines.

Circle letter (W) on reply card.

(X) COMPRESSORS

Clark Bros. Company, Inc., has announced a new catalog describing the Clark balanced/opposed motor driven compressors. The company states that



perfect balance is achieved by mounting cylinders in pairs—one on either side of the crankcase—and connecting them to the crankshaft with throws 180 deg apart. The compressors have one-piece, forged steel crankshafts, reinforced, semi-steel crankcases, and interchangeable, precision bearings. Most Clark balanced/opposed units are shipped completely assembled. Those too large for unit shipment are only partially disassembled. They also have an 8-in. stroke and are built in 2, 4, and 6-compressor cylinder sizes covering a range of 150 to 600 bhp.

Circle letter (X) on reply card.

(Y) METAL DETECTOR

The Eriez Manufacturing Company has released a new catalog on the "RCA Utility Metal Detector." This protecting device, made by the Radio Corporation of America and marketed by Eriez in the U. S. and Canada, indicates the presence of metallic particles of almost microscopic size, either magnetic or non-magnetic, in open or packaged non-metallic materials. The detector is designed to permit continuous inspection of non-metallic material that is fed through an aperture by a conveyor belt, vibrating conveyor, chute, or some other type of materials-handling equipment. As the material being inspected passes through the aperture, any metallic particle present actuates a signal or marking device, an automatic ejector or any combination of controls the operation may require. A great variety of materials can be tested due to the various sizes with round or rectangular apertures.

Circle letter (Y) on reply card.

(Z) HANGARS, SUPPORTS

Blaw-Knox Construction Company has announced a new catalog covering its complete line of adjustable pipe hangers, vibration eliminators, and supports. The rigid hanger assemblies, functional hangers, vibration eliminators, and the overhead roller assemblies are supplied as complete units, thus saving the customer engineering time. The various parts required are also included in the catalog. The technical section presents the information that would be necessary for the piping engineer to solve most hanger load problems, to determine the amount of expansion that must be allowed, and thus determine the hanger requirements for the particular pipe line under consideration. The spiral bound, 2-color booklet contains 95 pages, which include tables, diagrams, and pictures.

Circle letter (Z) on reply card.

(AA) LOW-PRESSURE CELLS

Baldwin-Lima-Hamilton Corporation has published a 2-page bulletin on its SR-4 low-pressure cells. The cells are of 0-10 to 0-100 psi capacity for measuring variations in gas or liquid pressures. The bulletin includes illustrations of the cells, wiring, diagram, dimensional diagrams, and specifications. These valves are well constructed and sensitive, and mechanically balanced so that the reading is substantially insensitive to linear acceleration in any direction, permitting them to be mounted in any position without change in indication, according to the manufacturer.

Circle letter (AA) on reply card.

(AB) ROD GUIDE

A rod selection guide for "Amscoating" with Amsco hardfacing products has just been released by American Manganese Steel Division of The American Brake Shoe Company. This chart breaks down into basic operations, the parts that can and should be hardfaced for longer life. The rod selection guide gives the name of the part, the recommended rod, sizes, and method of application. It also contains a description of the rods in the AMSCO line. The American Brake Shoe Company.

Circle letter (AB) on reply card.

(AC) APPARATUS APPLICATIONS

Victor Equipment Company has announced publication of its new apparatus catalog, 20-C. The purpose of this catalog is to present complete information on Victor apparatus through carefully planned illustrations and charts to make selection and ordering as easy as possible. The four-color apparatus catalog contains numerous cutaway diagrams, photographs, and specifications of various Victor equipment. Some of these products include adapters to adapt from regulator to cylinder, cutting torches, bushings, couplings, cable connectors, check valves, and many others.

Circle letter (AC) on reply card.

(AD) CYLINDERS

Calling attention to several installations of Ledeen cylinders in over a dozen different fields is Bulletin 152, just released by Ledeen Manufacturing Company. Following the bulletin's theme "Use a Cylinder and Save a Man", application of Ledeen cylinders is illustrated and described in such widely varied fields as chemical plants, oil refineries, plastics concrete plants, and lumber mills. In some instances manual power is either eliminated or reduced. In other applications work is done automatically or by remote control—or operation speed is increased.

Circle letter (AD) on reply card.

(AE) PUMPING MOTORS

E-M Synchronizer No. 34, just off the press, features the story of how the world's biggest motors for oil pipe line pumping were designed and built. Written by the designers of these motors, this article includes a discussion of the problems involved and their solution, plus many photographs showing features of construction incorporated in these motors. Another section in this 24-page, two-color booklet is devoted to cement manufacturing. Fully illustrated throughout, this magazine also includes articles on other uses of the motors. Electric Machinery Manufacturing Company.

Circle letter (AE) on reply card.

(AF) METALS CLASSIFICATION

The International Nickel Company, Inc., has issued a 46-page booklet entitled, "Identification of Metals and Alloys". Metals are given preliminary classification by density, the very heavy metals, heavy metals, light metals and alloys, and average density metals and alloys. The booklet describes each type with both charts and descriptions. Several pages are dedicated to identification of ferrous and non-ferrous metals and alloys. And a part of the appendix deals with the nominal chemical composition of some metals and alloys.

Circle letter (AF) on reply card.

(AG) SERVICES

United Engineers and Constructors, Inc., has issued a new 4-page cardboard booklet outlining the services that it is now offering. On the back cover are listed some of the companies for which they are now doing work. In addition to the gas plant engineering and construction services that this company has offered through the years, it is now providing complete services for the utilization of natural gas in the plant and in the distribution and transmission system for gas companies, either on a mixed gas or straight natural gas basis. Facilities provided the gas industry included every phase of engineering and construction work. The same service is offered in its complete pipe line construction services.

Circle letter (AG) on reply card.

(AH) TURBINES

Murray Iron Works Company has released a new bulletin on its Type H turbine. Some of the features listed in the bulletin include: Enclosed shaft through governor making it possible for the turbine to have a double extended shaft, spark-proof emergency trip, and convenient vertical hand valve position. Governor valve seats and steam strainer may easily be removed, and the turbine has large capacity bearing oil reservoirs (approximately 6 qt total capacity). Centerline support and heavy shaft construction provide unusually smooth operation and long-life.

Circle letter (AH) on reply card.

(AI) VENT VALVES

Black, Sivalls and Bryson, Inc., announces the publication of a new 24-page bulletin entitled "BS&B Combination Pressure-Vacuum Vent Valves." Complete descriptions are given on two models: VVFA, which includes a flame arrester element, and VVH, which does not. Printed in two-colors and well-illustrated with photographs and cross-section drawings, the attractive bulletin also includes 14 relieving capacity charts, one for each valve size. Operating data, specifications, and prices are also included.

Circle letter (AI) on reply card.

(AJ) TESTING, MEASURING EQUIPMENT

A new 80-page catalog summarizing for the first time under one cover all of the General Electric Company's testing and measuring equipment for laboratory and production line use, has been announced as available from the company. To be used primarily as a reference to the apparatus available for the complex measurements to be made in industry, the new catalog (GEC-1016) contains more than 150 photographs and diagrams and describes the uses, features, specifications, and prices of more than 130 G-E testing and measuring equipments. The new catalog also contains publication references to G-E bulletins that describe and illustrate each device in more detail.

Circle letter (AJ) on reply card.

(AK) DRILL PIPE

The National Supply Company has issued a new bulletin featuring sizes and description of the Spangweld drill pipe, a new drill pipe with welded connections. The 8-page three-color pocket-sized brochure by the Spang-Chalfant division of National Supply reports that the new pipe reduces the first cost of the drilling string. The drill pipe and tool joint are connected by welding instead of by threads, which are electroplated to resist initial scoring and galling. Included in the booklet is a list of Spangweld drill pipe sizes and types and a listing of division tubular offices, in various parts of the country.

Circle letter (AK) on reply card.

(AL) OIL AND GREASE SEALS

Complete information on the company's Klozure oil and grease seals for bearings is available in a 100-page catalog just published by The Garlock Packing Company. The catalog contains illustrations of all types of Klozures, typical applications, and a complete list of sizes and part numbers. In addition, this catalog describes in detail Garlock's mechanical pressure seals for rotary shafts.

Circle letter (AL) on reply card.

(AM) PRODUCING FACILITIES

A 40-page pocket-size booklet has been issued by Hobart Brothers Company, depicting the company's facilities and production operations in its plant. The booklet is a virtual trip through the Troy, Ohio, plant, where 20 acres of flow-line production methods and equipment keep materials moving in and out of Hobart's modern daylight buildings. The booklet shows the research and development department, new buildings added, punch presses, hydraulic presses, winding department, fields and coils, drill presses, automatic screw machines, and many other departments of the Hobart plant.

Circle letter (AM) on reply card.

(AN) SPRAY NOZZLES

Up-to-date information on non-clogging spray nozzles for cleaning all kinds of materials, screens, fruits, vegetables, etc., is given in a new 4-page illustrated Folder No. 2386 released by Link-Belt Company. These nozzles consist simply of a scientifically shaped, curved bronze deflector having a smoothly-polished water contact surface and a sharp, true discharge edge—with a U-bolt and two hexagon nuts for holding the deflector in proper position on a pipe drilled with a plain hole at each desired spray location.

Circle letter (AN) on reply card.

(AO) CARBON GRAPHITE

A new 20-page catalog section describing and illustrating "National" Carbon and Graphite and "Karbate" impervious carbon and graphite products is now available from National Carbon Company, division of Union Carbide and Carbon Corporation. Products made of carbon and graphite in grades from porous to impervious for applications in the chemical and process, metallurgical, mechanical, and electrical fields are fully described. Information is given on sizes and physical characteristics of each product, in addition to many useful tables such as, typical physical properties of carbon and graphite products, Corrosion resistance of "Karbate" products, heat conductivity of various materials, performance curves of "Karbate" pumps, permeability of porous carbon and graphite, etc. Carbon graphite is resistant to almost all corrosive chemicals, ease of machining, and fabrication.

Circle letter (AO) on reply card.

(AP) HYDRAULIC JACKS

Complete information, including specifications and application data, on hydraulic jacks, is offered in a new bulletin just issued by Templeton, Kenly and Company. This 8-page letter-file size folder, known as Hydraulic 51-R, contains photographs, detail drawings and tabulated data on hydraulic equipment in capacities of from 10 to 100 tons. Simplex Re-Mo-Trol pumps and rams are featured, including a full listing of accessories and attachments. Other jacks shown are Simplex-Jenny hydraulic pullers, standard hydraulic jacks, and the new Simplex Rol-Toe foot lift hydraulic jacks.

Circle letter (AP) on reply card.

(AQ) STEEL TUBING

The scope of sizes of electric resistance welded carbon steel tubing produced by the welded tube division of The Babcock and Wilcox Tube Company, has been broadened. As an aid to those using ERW tubing for either mechanical or pressure purposes the company has published a chart covering the range of sizes they now produce. This chart is broken down to reflect both average wall and minimum wall requirements in .08/.18 and .20/.30 per cent carbon steel grades produced to various ASTM, ASME, AAR and government specifications for pressure tubing and standard specifications for mechanical tubing. It covers a size range of ½ to 4 in. OD and .032 in.to .213 in. average wall thickness or .020 to .203 in. minimum thickness.

Circle letter (AQ) on reply card.

(AR) GAS SCRUBBERS

Peabody Engineering Corporation has published a 2-color folder on its new gas scrubber. The bulletin is complete with capacity curve sheet, cross section diagram, and other technical data including typical installation pictures. Peabody scrubbers are used in the recovery of products, the purification of gases, and the elimination of atmospheric pollution. Peabody units are built fully shop-assembled up to 11 ft 6 in. diameter, and units larger than this are field erected. Included in the booklet are descriptive diagrams, and charts.

Circle letter (AR) on reply card.

(AS) VALVES

Barksdale Valves have just published comprehensive data on the new Crescent valve line. Performance characteristics include: Continuous fast cycling, up to 600 cycles per minute without over heating. Production line valves have registered over 40,000,000 cycles on test. Valves come in ¼, ⅜, ½, and ¾-in. sizes for single and dual pressure operation on air, water, or light oil from 0 to 150 psi. Solenoids are available for all standard voltages A-C and D-C. Solenoids and pilot valve parts are the same for all sizes, to simplify maintenance.

Circle letter (AS) on reply card.

(AT) PORTABLE ELEVATOR

New features designed into its portable material elevator are graphically illustrated and simply described by American Hoist and Derrick Company in a new catalog just released. Users and prospective users of material elevators will like the larger, stronger platform, and new method of hooking the platform or concrete bucket to traveling carriage. Assembly of the elevator has been speeded by using pins wherever practical, new type tower section splices and a new single unit tower head. The concrete bucket tripping device is attached to tower and can be set for any dumping height in a matter of minutes.

Circle letter (AT) on reply card.

(AU) CONTROLLERS

A new bulletin, No. 1320, on TAG self operated temperature and pressure controllers is now available from Tagliabue Instruments Division, Weston Electrical Instrument Corporation. Designed for use in virtually every kind of industrial plant, TAG temperature controllers have a wide variety of applications including use on hot water storage heaters, tanks, canning retorts, exhaust boxes, textile dryers, and scouring bowls. Control ranges vary from as low as 20 to 60 F to as high as 255 to 300 F. The steam, air, water, or other media under control supplies the motive force for these controllers.

Circle letter (AU) on reply card.

CORROSION
SCALE AND ALGAE
Controlled
IN
PETROLEUM PLANTS
BY
HAERING ORGANIC GLUCOSATES*

Quachrom Glucosate
Sodium Chrom Glucosate
Tetra Phospho Glucosate
Pyro Glucosate

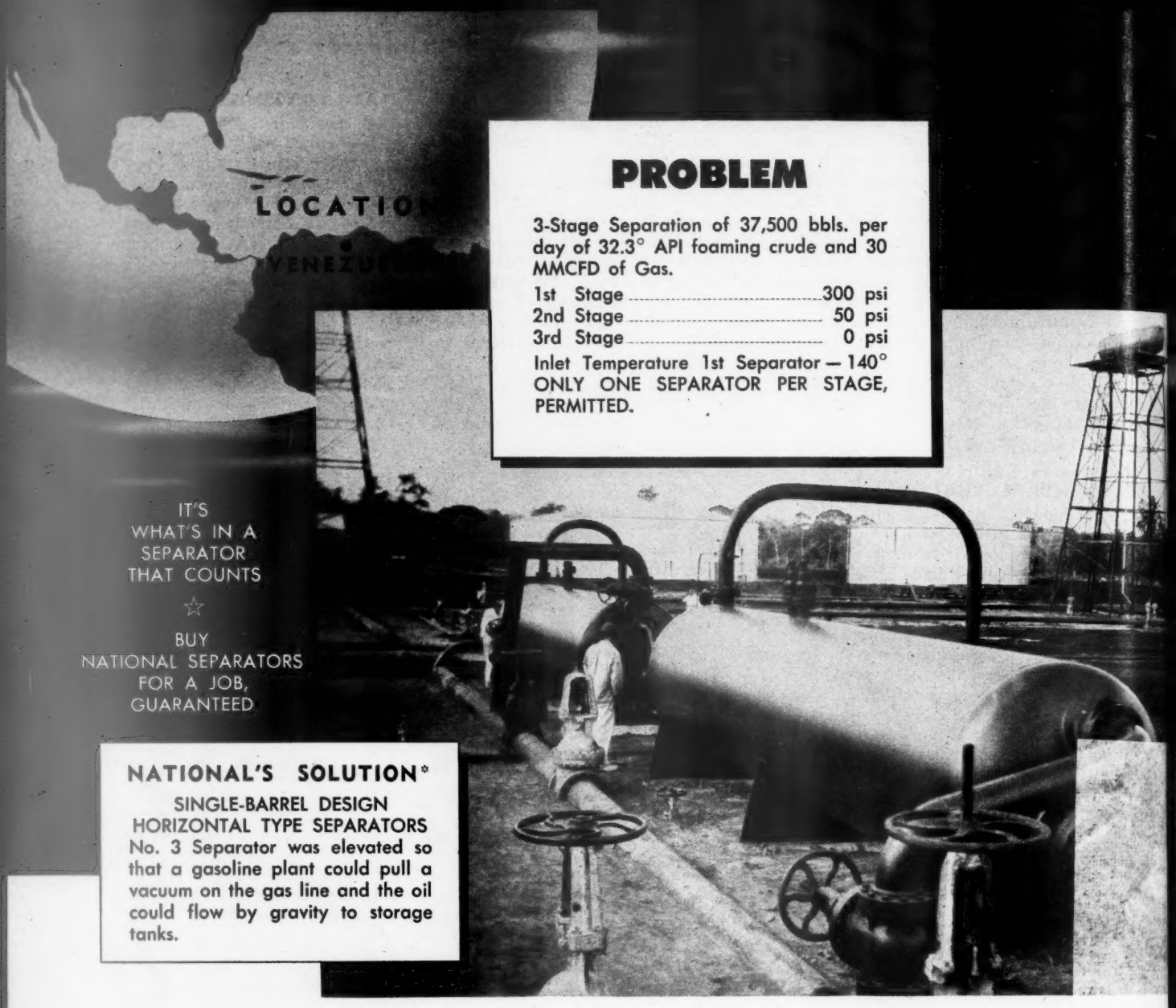
*REG. U. S. PAT OFF.

Over years of service these Glucosates have an unexcelled record of satisfactory performance

WRITE ON YOUR LETTERHEAD FOR SPECIAL LITERATURE

D. W. HAERING & CO., INC.

GENERAL OFFICES
P. O. BOX 6037, SAN ANTONIO, TEXAS
CHICAGO OFFICE: 205 West Wacker Drive



PROBLEM

3-Stage Separation of 37,500 bbls. per day of 32.3° API foaming crude and 30 MMCFD of Gas.

1st Stage	300 psi
2nd Stage	50 psi
3rd Stage	0 psi

Inlet Temperature 1st Separator — 140°
ONLY ONE SEPARATOR PER STAGE, PERMITTED.

IT'S
WHAT'S IN A
SEPARATOR
THAT COUNTS

☆

BUY
NATIONAL SEPARATORS
FOR A JOB,
GUARANTEED

NATIONAL'S SOLUTION*

SINGLE-BARREL DESIGN
HORIZONTAL TYPE SEPARATORS
No. 3 Separator was elevated so that a gasoline plant could pull a vacuum on the gas line and the oil could flow by gravity to storage tanks.

NATIONAL FURNISHED SEPARATORS WITH THE FOLLOWING SIZES AND OPERATIONAL CAPACITIES

	Press. on Separator psi	Bbls. oil per day	Std. Cu. Ft. Gas Per day
No. 1 Separator — 5′ x 22′-6″ long	300		22,700,000
No. 2 Separator — 5′ x 22′-6″ long	50		7,200,000
No. 3 Separator — 6′ x 20′ long	0	37,500	194,000
TOTALS		37,500	30,094,000

Had only one stage of separation been utilized at 300 psi, over 7,000,000 cu. ft. per day would have been liberated in the stock tanks.

** As detailed in "TANK TOPICS," January, 1949.*

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA